

**İstanbul Gelişim Üniversitesi
Sağlık Bilimleri Dergisi
(IGUSABDER)**

Sayı / Issue: 30

Yıl / Year: 2026

**Istanbul Gelisim University
Journal of Health Sciences
(IGUSABDER)**

ISSN: 2536-4499

e-ISSN: 2602-2605

© İstanbul Gelişim Üniversitesi Yayınları

© *Istanbul Gelisim University Press*

Sertifika No / Certificate Number: 47416

Her hakkı saklıdır. *All rights reserved.*

İstanbul Gelişim Üniversitesi kurumsal yayını olan Sağlık Bilimleri Dergisi, yılda üç kez yayımlanan uluslararası hakemli bir dergidir. Makalelerdeki görüş, düşünce, varsayım veya öneriler eser sahiplerine aittir; İstanbul Gelişim Üniversitesi sorumlu tutulamaz.

The Journal of Health Sciences is an international peer-reviewed journal and will be published three times a year. The opinions, thoughts, postulations or proposals within the articles are but reflections of the authors and do not, in any way, represent those of the Istanbul Gelisim University.

İLETİŞİM BİLGİLERİ / COMMUNICATION:

**İstanbul Gelişim Üniversitesi, Sağlık Bilimleri Fakültesi,
Cihangir Mah. Şehit Jandarma Komando Er Hakan Öner Sk.
No: 1, 34310 Avcılar / İstanbul / TÜRKİYE**

Tel: +90 212 4227000 Dahili 7333

Belgeç: +90 212 4227401

E-posta: igusabder@gelisim.edu.tr

Ağ sayfası: <https://igusabder.gelisim.edu.tr>

<https://twitter.com/igusabder>

Twitter: [@igusabder](https://twitter.com/igusabder)

Baskı ve cilt:

Printing and binding:

Servet İşler

Sertifika No. 40352

Tel: +90 212 5939467

E-posta: islercory@hotmail.com

İSTANBUL GELİŞİM ÜNİVERSİTESİ SAĞLIK BİLİMLERİ DERGİSİ:
İNDEKSLENME VE HARMANLANMA BİLGİLERİ /
ISTANBUL GELİSİM UNIVERSITY JOURNAL OF HEALTH SCIENCES:
INFORMATION ABOUT INDEXING AND HARVESTING

DİZİNLENME / INDEXING

Dergimiz, TÜBİTAK ULAKBİM TR Dizin tarafından 2020 yılından bu yana dizinlenmektedir.



Dergimiz, Türkiye Atıf Dizinini tarafından 2017 yılından bu yana dizinlenmektedir.



HARMANLANMA / HARVESTING

Dergimizin içeriği Dspace@Gelişim Kurumsal Açık Erişim Arşivi (<https://acikerisim.gelisim.edu.tr>) ve Avrupa Komisyonu'nun OpenAIRE 2020 Açık Erişim Projesi (The OpenAIRE2020 Project) (<https://www.openaire.eu/openaire2020-project>) tarafından harmanlanmaktadır.





İSTANBUL
GELİŞİM
ÜNİVERSİTESİ

İSTANBUL GELİŞİM ÜNİVERSİTESİ SAĞLIK BİLİMLERİ DERGİSİ (IGUSABDER)

Uluslararası Hakemli Dergi

Sayı 30 • Ağustos • 2026 • ISSN: 2536-4499 • e-ISSN: 2602-2605

İstanbul Gelişim Üniversitesi Adına Sahibi

Rektör Prof. Dr. Bahri ŞAHİN

Onursal Kurul

Dr. Öğr. Üyesi Necip Ozan TİRYAKİOĞLU

Yayın Kurulu

Prof. Dr. Mahir GÜNDAY

Prof. Dr. S. Arda ÖZTÜRKCAN

Prof. Dr. Yakup Bilge SÜREL

Doç. Dr. H. Merve BAYRAM

Dr. Öğr. Üyesi Abdullah Yüksel BARUT

Editör

Dr. Öğr. Üyesi Abdullah Yüksel BARUT

Editör Yardımcıları

Prof. Dr. S. Arda ÖZTÜRKCAN

Doç. Dr. H. Merve BAYRAM

Yazı İşleri Kurulu

Dr. Öğr. Üyesi Hande Nur ONUR ÖZTÜRK, Uzm. Ahmet Şenol ARMAĞAN,

Arş. Gör. Dr. Ebru DURUSOY

Türkçe Dil Editörleri

Dr. Öğr. Üyesi Beyza Aşlı BİLSEL

Arş. Gör. Dr. Ebru DURUSOY

Arş. Gör. Semanur OKTAY ALKAN

İngilizce Dil Editörleri

Dr. Öğr. Üyesi Havva SAĞLAM

Dr. Öğr. Üyesi Emrah TÜNCER

Dr. Öğr. Üyesi Tuğba TÜRKCAN

Dr. Öğr. Üyesi Gizem UZLU

Arş. Gör. Şebnem ÇELİK UÇURAN

Arş. Gör. Azize KÖSEOĞLU

Sorumlu Yazı İşleri Müdürü

Uzm. Ahmet Şenol ARMAĞAN

Kapak Tasarımı

Kübra ALBAYRAK

Servet İŞLER

İLETİŞİM:

İstanbul Gelişim Üniversitesi, Sağlık Bilimleri Fakültesi,
Cihangir Mah. Şehit Jandarma Komando Er Hakan Öner Sk. No: 1,
34310 Avcılar / İstanbul / TÜRKİYE

Tel: +90 212 4227000 Dahili: 7333

Belgeç: +90 212 4227401

E-posta: igusabder@gelisim.edu.tr

Ağ sayfası: <https://igusabder.gelisim.edu.tr>

Twitter: [@igusabder](https://twitter.com/igusabder)



ISTANBUL
GELISIM
UNIVERSITY

ISTANBUL GELISIM UNIVERSITY JOURNAL OF HEALTH SCIENCES (IGUSABDER)
International Peer–Reviewed Journal
Issue 30 • August • 2026 • ISSN: 2536-4499 • e-ISSN: 2602-2605

Owner on Behalf of Istanbul Gelisim University

Rector Prof. Dr. Bahri ŞAHİN

Honorary Board

Asst. Prof. Dr. Necip Ozan TİRYAKİOĞLU

Editorial Board

Prof. Dr. Mahir GÜNDAY

Prof. Dr. S. Arda ÖZTÜRKCAN

Prof. Dr. Yakup Bilge SÜREL

Assoc. Prof. Dr. H. Merve BAYRAM

Asst. Prof. Dr. Abdullah Yüksel BARUT

Editor

Asst. Prof. Dr. Abdullah Yüksel BARUT

Assistant Editors

Prof. Dr. S. Arda ÖZTÜRKCAN

Assoc. Prof. Dr. H. Merve BAYRAM

Publication Board

Asst. Prof. Dr. Hande Nur ONUR ÖZTÜRK, Specialist Ahmet Şenol ARMAĞAN,

Res. Asst. Dr. Ebru DURUSOY

Turkish Language Editors

Asst. Prof. Dr. Beyza Aşlı BİLSEL

Res. Asst. Dr. Ebru DURUSOY

Res. Asst. Semanur OKTAY ALKAN

English Language Editors

Asst. Prof. Dr. Havva SAĞLAM

Asst. Prof. Dr. Emrah TÜNCER

Asst. Prof. Dr. Tuğba TÜRKCAN

Asst. Prof. Dr. Gizem UZLU

Res. Asst. Şebnem ÇELİK UÇURAN

Res. Asst. Azize KÖSEOĞLU

Director of Editorial Office

Specialist Ahmet Şenol ARMAĞAN

Cover Design

Kübra ALBAYRAK

Servet İŞLER

COMMUNICATION:

Istanbul Gelisim University, Faculty of Health Sciences,

Sehit Jandarma Komando Er Hakan Oner Sk. No: 1,

34310 Avcılar / Istanbul / TÜRKİYE

Phone: +90 212 4227000 Ext. 7333

Fax: +90 212 4227401

E-mail: igusabder@gelisim.edu.tr

Web page: <https://igusabder.gelisim.edu.tr>

Twitter: [@igusabder](https://twitter.com/igusabder)

BİLİMSEL DANIŞMA KURULU

Prof. Dr. Makbule Meziyet ARI - İstanbul Gelişim Üniv. - TÜRKİYE mmari@gelisim.edu.tr
Prof. Dr. Ali Rıza CENAL - İstanbul Gelişim Üniv. - TÜRKİYE arcenal@gelisim.edu.tr
Prof. Dr. Ahmet Tan CİMİLLİ - Sağlık Bilimleri Üniv. - TÜRKİYE ahmettan.cimilli@sbu.edu.tr
Prof. Dr. Anayit MARGİRİT COŞKUN - İstanbul Atlas Üniv. - TÜRKİYE coskunano@yahoo.com
Prof. Dr. İkbâl ÇAVDAR - İstanbul Atlas Üniv. - TÜRKİYE ikbal.cavdar@atlas.edu.tr
Prof. Dr. Fatma ÇELİK - Biruni Üniv. - TÜRKİYE fcelik@biruni.edu.tr
Prof. Dr. Ferda DOKUZTUĞ ÜÇSULAR - Rumeli Hisarı Akademi - TÜRKİYE ferda@rhakademi.com
Prof. Dr. Veli DUYAN - Ankara Üniv. - TÜRKİYE vduyan@health.ankara.edu.tr
Prof. Dr. Nefise Semra ERKAN - İstanbul Gelişim Üniv. - TÜRKİYE nserkan@gelisim.edu.tr
Prof. Dr. Metin ERGÜN - Ege Üniv. - TÜRKİYE metin.ergun@ege.edu.tr
Prof. Dr. Méghit Boumédiène KHALED - Djillali Liabes Univ. CEZAYİR boumedienemeghit.khaled@dl.univ-sba.dz
Prof. Dr. Nuri Özgür KILIÇESMEZ - Sağlık Bilimleri Üniv. - TÜRKİYE okilickesmez@yahoo.com
Prof. Dr. Gül KIZILTAN - Başkent Üniv. - TÜRKİYE gkizilta@baskent.edu.tr
Prof. Dr. Abdurrahim KOÇYİĞİT - Bezmialem Vakıf Üniv. - TÜRKİYE abdurrahimkocyigit@yahoo.com
Prof. Dr. Mehmet KUTLU - Hitit Üniv. - TÜRKİYE mehmetkutlu@hitit.edu.tr
Prof. Dr. Mustafa NİZAMLIOĞLU - İstanbul Gelişim Üniv. - TÜRKİYE mnizamlioglu@gelisim.edu.tr
Prof. Dr. Sıdika OĞUZ - Marmara Üniv. - TÜRKİYE soguz@marmara.edu.tr
Prof. Dr. Arif ÖNDER - İstanbul Gelişim Üniv. - TÜRKİYE aonder@gelisim.edu.tr
Prof. Dr. Levent ÖZTÜRK - Trakya Üniv. - TÜRKİYE leventozturk@trakya.edu.tr
Prof. Dr. G.C. PAPADOPOULOS - Selanik Aristoteles Üniv. - YUNANİSTAN gpapadop@vet.auth.gr
Prof. Dr. Hatice PEK - Haliç Üniv. - TÜRKİYE haticepek@halic.edu.tr
Prof. Dr. Ayda Gülden PEKCAN - Hasan Kalyoncu Üniv. - TÜRKİYE gulden.pekcan@hku.edu.tr
Prof. Dr. Helga REFSUM - Oslo Üniv. - NORVEÇ helga.refsum@medisin.uio.no
Prof. Dr. Osman SAĞDIÇ - Yıldız Teknik Üniv. - TÜRKİYE osagdic@yildiz.edu.tr
Prof. Dr. Daniel SERGELİDİS - Aristotle University of Thessalonik - YUNANİSTAN dsergkel@vet.auth.gr
Prof. Dr. Haydar SUR - Üsküdar Üniv. - TÜRKİYE haydar.sur@uskudar.edu.tr
Prof. Dr. Yakup Bilge SÜREL - TÜRKİYE
Prof. Dr. Mehveş TARIM - Marmara Üniv. - TÜRKİYE mtarim@marmara.edu.tr
Prof. Dr. Şaban TEKİN - Sağlık Bilimleri Üniv. - TÜRKİYE saban.tekin@sbu.edu.tr
Prof. Dr. Emel YURTSEVER - İstanbul Sabahattin Zaim Üniv. - TÜRKİYE emel.yesilkayali@izu.edu.tr
Doç. Dr. Edibe EGİL - İstanbul Aydın Üniv. - TÜRKİYE edibeegil@aydin.edu.tr
Doç. Dr. Nürten ELKİN - İstanbul Gelişim Üniv. - TÜRKİYE nelkin@gelisim.edu.tr
Doç. Dr. Neşe KISKAÇ - İstanbul Esenyurt Üniv. - TÜRKİYE nesekiskac@esenyurt.edu.tr
Doç. Dr. Halime PULAT DEMİR - İstanbul Beykent Üniv. - TÜRKİYE halimedemir@beykent.edu.tr
Doç. Dr. Hasan Basri SAVAŞ - Mardin Artuklu Üniv. - TÜRKİYE hasansavas@artuklu.edu.tr
Dr. Öğr. Üyesi Bahar Nur AKDOĞAN - İstanbul Gelişim Üniv. - TÜRKİYE bnkanbur@gelisim.edu.tr
Dr. Öğr. Üyesi Esra ALDIRMAZ - Uluslararası Final Üniv. - KKTC esra.aldirmaz@final.edu.tr
Dr. Öğr. Üyesi Başak GÖKÇE ÇÖL - Dokuz Eylül Üniv. - TÜRKİYE basakgokce.col@deu.edu.tr
Dr. Öğr. Üyesi İsmail A. M. ELHATY - İstanbul Gelişim Üniv. - TÜRKİYE iaeismail@gelisim.edu.tr
Dr. Öğr. Üyesi Ebru KARPUZOĞLU - İstanbul Beykent Üniv. - TÜRKİYE ebrukarpuzoglu@beykent.edu.tr
Dr. Öğr. Üyesi Derya KAVGAOĞLU - İstanbul Gelişim Üniv. - TÜRKİYE dkavgaoglu@gelisim.edu.tr
Dr. Öğr. Üyesi Ash KAYA - İstanbul Gelişim Üniv. - TÜRKİYE askaya@gelisim.edu.tr
Dr. Öğr. Üyesi Fikri KÖKSAL - TÜRKİYE fkksal@gelisim.edu.tr
Dr. Öğr. Üyesi Leena MAUNULA - Helsinki Üniv. - FİNLANDİYA Leena.Maunula@helsinki.fi
Dr. Öğr. Üyesi Nasir MUSTAFA - İstanbul Gelişim Üniv. - TÜRKİYE nmustafa@gelisim.edu.tr
Dr. Öğr. Üyesi Mahruk RASHİDİ - İstanbul Gelişim Üniv. - TÜRKİYE mrashidi@gelisim.edu.tr
Dr. Öğr. Üyesi Emrah TUNCER - İstanbul Gelişim Üniv. - TÜRKİYE etuncer@gelisim.edu.tr
Dr. Öğr. Üyesi Yonca Güneş YÜCEL ATALAY - İstanbul Gelişim Üniv. - TÜRKİYE ygyucel@gelisim.edu.tr
Dr. Öğr. Üyesi Hina ZAHOR - İstanbul Gelişim Üniv. - TÜRKİYE hzahoor@gelisim.edu.tr
Dr. Öğr. Üyesi Selva ZEREN - İstanbul Beykent Üniv. - TÜRKİYE selvazeren@beykent.edu.tr
Dr. Öğr. Üyesi Ashifa K. Mohammed ASHRAF - İstanbul Gelişim Üniv. - TÜRKİYE akariveliparambil@gelisim.edu.tr
Dr. A. Emre BARUT - Amazon - ABD
Dr. Noman NASIR - PAKİSTAN drnomannasir@hotmail.com
Diyetisten Fatma TURANLI - Acıbadem Hastanesi - TÜRKİYE fatma.turanli@acibadem.com.tr

BU SAYININ HAKEMLERİ

Prof. Dr. Seda CAN
Prof. Dr. Cafer Sadık ZORKUN
Prof. Dr. Hüseyin ÇAKAN
Prof. Dr. Gökmen Umut ERDEM
Prof. Dr. Mehmet GÜL
Prof. Dr. Ayfer KAMALI POLAT
Prof. Dr. Özer SELİMOĞLU
Prof. Dr. Sibel TETİK
Doç. Dr. Nazlı Nur ASLAN ÇİN

Doç. Dr. Adem DOĞANER
Doç. Dr. Recep DOKUYUCU
Doç. Dr. Nurten ELKİN
Doç. Dr. Vildan ENİSOĞLU ATALAY
Doç. Dr. İzzet ERDEM
Doç. Dr. Serkan GÖNEN
Doç. Dr. Mehmet GÜMÜŞTAŞ
Doç. Dr. Rouane JAOUAD
Doç. Dr. Bayram KAYA
Doç. Dr. M. Oğuzhan KILINÇEL
Doç. Dr. İpek KÖSE TOSUNÖZ
Doç. Dr. Burak MENEK
Doç. Dr. Şamil ÖZTÜRK
Doç. Dr. Ömer ŞEVGİN
Doç. Dr. Derya TÜLÜCE
Doç. Dr. Sevda UZUN
Doç. Dr. Yücel YILMAZ
Dr. Öğr. Üyesi Hasan Fatih AKGÖZ
Dr. Öğr. Üyesi Mustafa Ferit AKKURT
Dr. Öğr. Üyesi Ünal ALPAY
Dr. Öğr. Üyesi Meltem ASLAN
Dr. Öğr. Üyesi Numan ATILGAN
Dr. Öğr. Üyesi Tangül AYTUR ÖZEN
Dr. Öğr. Üyesi Sema BÜĞÜŞAN ORUÇ
Dr. Öğr. Üyesi Başak CAN
Dr. Öğr. Üyesi Sultan ÇAKMAK TANRIVER
Dr. Öğr. Üyesi Gülşah ÇAMCI
Dr. Öğr. Üyesi Ayseren ÇEVİK
Dr. Öğr. Üyesi Hülya DİĞER
Dr. Öğr. Üyesi Belgin DİLMEN
Dr. Öğr. Üyesi Gülşen FİLAZOĞLU ÇOKLUK
Dr. Öğr. Üyesi Aylar KARGAR MOHAMMADINAZHAD
Dr. Öğr. Üyesi Mustafa KAVAK
Dr. Öğr. Üyesi Ash KAYA
Dr. Öğr. Üyesi Gizem KÖPRÜLÜLÜ KÜÇÜK
Dr. Öğr. Üyesi Özlem ÖZDEMİR
Dr. Öğr. Üyesi Rümeysa ÖZAYABAKAN
Dr. Öğr. Üyesi Alper PERÇİN
Dr. Öğr. Üyesi Azade SARI
Dr. Öğr. Üyesi Mine SEYYAH
Dr. Öğr. Üyesi Yunus ŞAHİNLER
Dr. Öğr. Üyesi Didem TETİK KÜÇÜKELÇİ
Dr. Öğr. Üyesi Engin YAVAŞ
Dr. Öğr. Üyesi Deniz YILDIZ
Dr. Öğr. Üyesi Yonca Güneş YÜCEL ATALAY
Öğr. Gör. Dr. Aysel TAMTAMIŞ KURT
Arş. Gör. Dr. İsmail AYVAZ
Arş. Gör. Dr. Ece GÜMÜŞOĞLU ACAR
Arş. Gör. Dr. Berk KORKUT
Dr. SC Rozita TAMJIDIFAR
Dr. Sebla AK
Dr. Ramazan EMİRALİOĞLU
Dr. Hayrettin GÖÇMEN
Dr. Alp Giray KAYA
Dr. Sajjan PAL
Dr. Şeyma SÜNBÜL

SCIENTIFIC ADVISORY BOARD

Prof. Dr. Makbule Meziyet ARI - Istanbul Gelişim Univ. – TÜRKİYE mmari@gelisim.edu.tr
Prof. Dr. Ali Rıza CENAL - Istanbul Gelişim Univ. – TÜRKİYE arcenal@gelisim.edu.tr
Prof. Dr. Ahmet Tan CİMİLLİ - Sağlık Bilimleri Univ. – TÜRKİYE ahmettan.cimilli@sbu.edu.tr
Prof. Dr. Anayit MARGİRİT COŞKUN – Istanbul Atlas Univ. – TÜRKİYE coskunano@yahoo.com
Prof. Dr. İkbāl ÇAVDAR – Istanbul Atlas Univ. – TÜRKİYE ikbal.cavdar@atlas.edu.tr
Prof. Dr. Fatma ÇELİK – Biruni Univ. - TÜRKİYE fcelik@biruni.edu.tr
Prof. Dr. Ferda DOKUZTUĞ ÜÇSULAR - Rumeli Hisarı Akademi - TÜRKİYE ferda@rhakademi.com
Prof. Dr. Veli DUYAN – Ankara Univ. – TÜRKİYE vduyan@health.ankara.edu.tr
Prof. Dr. Nefise Semra ERKAN - Istanbul Gelişim Univ. – TÜRKİYE nserkan@gelisim.edu.tr
Prof. Dr. Metin ERGÜN – Ege Univ. - TÜRKİYE metin.ergun@ege.edu.tr
Prof. Dr. Méghit Boumediène KHALED - Djillali Liabes Univ. - ALGERIA boumedienemeghit.khaled@dl.univ-sba.dz
Prof. Dr. Nuri Özgür KILIÇESMEZ - Sağlık Bilimleri Univ. – TÜRKİYE okilickesmez@yahoo.com
Prof. Dr. Gül KIZILTAN – Başkent Univ. - TÜRKİYE gkizilta@baskent.edu.tr
Prof. Dr. Abdurrahim KOÇYİĞİT - Bezmialem Vakıf Univ. – TÜRKİYE abdurrahimkocyigit@yahoo.com
Prof. Dr. Mehmet KUTLU - Hitit Univ. - TÜRKİYE mehmetkutlu@hitit.edu.tr
Prof. Dr. Mustafa NİZAMLIOĞLU - Istanbul Gelişim Univ. - TÜRKİYE mnizamlioglu@gelisim.edu.tr
Prof. Dr. Sıdika OĞUZ - Marmara Univ. - TÜRKİYE soguz@marmara.edu.tr
Prof. Dr. Arif ÖNDER - Istanbul Gelişim Univ. – TÜRKİYE aonder@gelisim.edu.tr
Prof. Dr. Levent ÖZTÜRK – Trakya Univ. - TÜRKİYE leventozturk@trakya.edu.tr
Prof. Dr. G.C. PAPADOPOULOS – Selanik Aristoteles Univ. - GREECE gpadapop@vet.auth.gr
Prof. Dr. Hatice PEK – Haliç Univ. – TÜRKİYE haticepek@halic.edu.tr
Prof. Dr. Ayda Gülden PEKCAN – Hasan Kalyoncu Univ. - TÜRKİYE gulden.pekcan@hku.edu.tr
Prof. Dr. Helga REFSUM – Oslo Univ. – NORWAY helga.refsum@medisin.uio.no
Prof. Dr. Osman SAĞDIÇ – Yıldız Teknik Univ. – TÜRKİYE osagdic@yildiz.edu.tr
Prof. Dr. Daniel SERGELİDİS – Aristotle University of Thessalonik - GREECE dsergkel@vet.auth.gr
Prof. Dr. Haydar SUR – Üsküdar Univ. - TÜRKİYE haydar.sur@uskudar.edu.tr
Prof. Dr. Yakup Bilge SÜREL - TÜRKİYE
Prof. Dr. Mehveş TARIM - Marmara Univ. – TÜRKİYE mtarim@marmara.edu.tr
Prof. Dr. Şaban TEKİN - Sağlık Bilimleri Univ. – TÜRKİYE saban.tekin@sbu.edu.tr
Prof. Dr. Emel YURTSEVER - Istanbul Sabahattin Zaim Univ. – TÜRKİYE emel.yesilkayali@izu.edu.tr
Assoc. Prof. Dr. Edibe EGİL - Istanbul Aydın Univ. - TÜRKİYE edibeegil@aydin.edu.tr
Assoc. Prof. Dr. Nürten ELKİN - Istanbul Gelişim Univ. - TÜRKİYE nelkin@gelisim.edu.tr
Assoc. Prof. Dr. Neşe KISKAÇ - Istanbul Esenyurt Univ. – TÜRKİYE nesekiskac@esenyurt.edu.tr
Assoc. Prof. Dr. Halime PULAT DEMİR - Istanbul Beykent Univ. - TÜRKİYE halimedemir@beykent.edu.tr
Assoc. Prof. Dr. Hasan Basri SAVAŞ - Mardin Artuklu Univ. – TÜRKİYE hasansavas@artuklu.edu.tr
Assoc. Prof. Dr. Yonca SEVİM - Bahçeşehir Univ. - TÜRKİYE yonca.sevim@hes.bau.edu.tr
Asst. Prof. Dr. Bahar Nur AKDOĞAN - Istanbul Gelişim Univ. – TÜRKİYE bnkanbur@gelisim.edu.tr
Asst. Prof. Dr. Esra ALDIRMAZ – Uluslararası Final Univ. – TRNC esra.aldirmaz@final.edu.tr
Asst. Prof. Dr. Başak Gökçe ÇÖL - Dokuz Eylül Univ. - TÜRKİYE basakgokce.col@deu.edu.tr
Asst. Prof. Dr. İsmail A. M. ELHATY - Istanbul Gelişim Univ. – TÜRKİYE iaeismail@gelisim.edu.tr
Asst. Prof. Dr. Ebru KARPUZOĞLU – Istanbul Beykent Univ. - TÜRKİYE ebrukarpuzoglu@beykent.edu.tr
Asst. Prof. Dr. Derya KAVGAOĞLU - Istanbul Gelişim Univ. – TÜRKİYE dkavgaoglu@gelisim.edu.tr
Asst. Prof. Dr. Ash KAYA - Istanbul Gelişim Univ. – TÜRKİYE aslakaya@gelisim.edu.tr
Asst. Prof. Dr. Fikri KÖKSAL - TÜRKİYE fkoksal@gelisim.edu.tr
Asst. Prof. Dr. Leena MAUNULA – Helsinki Univ. – FINLAND Leena.Maunula@helsinki.fi
Asst. Prof. Dr. Nasır MUSTAFA - Istanbul Gelişim Univ. – TÜRKİYE nmustafa@gelisim.edu.tr
Asst. Prof. Dr. Mahruk RASHİDİ - Istanbul Gelişim Univ. – TÜRKİYE mrashidi@gelisim.edu.tr
Asst. Prof. Dr. Emrah TUNCER - Istanbul Gelişim Univ. – TÜRKİYE etuncer@gelisim.edu.tr
Asst. Prof. Dr. Yonca Güneş YÜCEL ATALAY - Istanbul Gelişim Univ. – TÜRKİYE ygyucel@gelisim.edu.tr
Asst. Prof. Dr. Hina ZAHOR - Istanbul Gelişim Univ. – TÜRKİYE hzahoor@gelisim.edu.tr
Asst. Prof. Dr. Selva ZEREN - Istanbul Beykent Univ. - TÜRKİYE selvazeren@beykent.edu.tr
Asst. Prof. Dr. Ashifa K. Mohammed ASHRAF – Istanbul Gelisim Univ. – TÜRKİYE akariveliparambil@gelisim.edu.tr
Dr. A. Emre BARUT – Amazon – UNITED STATES
Dr. Noman NASIR - PAKISTAN drnomannasir@hotmail.com
Dietician Fatma TURANLI - Acıbadem Hospital - TÜRKİYE fatma.turanli@acibadem.com.tr

REFEREES FOR THIS ISSUE

Prof. Dr. Seda CAN
Prof. Dr. Cafer Sadık ZORKUN
Prof. Dr. Hüseyin ÇAKAN
Prof. Dr. Gökmen Umut ERDEM
Prof. Dr. Mehmet GÜL
Prof. Dr. Ayfer KAMALI POLAT
Prof. Dr. Özer SELİMOĞLU
Prof. Dr. Sibel TETİK

Assoc. Prof. Dr. Nazlı Nur ASLAN ÇİN
Assoc. Prof. Dr. Adem DOĞANER
Assoc. Prof. Dr. Recep DOKUYUCU
Assoc. Prof. Dr. Nurten ELKİN
Assoc. Prof. Dr. Vildan ENİSOĞLU ATALAY
Assoc. Prof. Dr. İzzet ERDEM
Assoc. Prof. Dr. Serkan GÖNEN
Assoc. Prof. Dr. Mehmet GÜMÜŞTAŞ
Assoc. Prof. Dr. Rouane JAOUAD
Assoc. Prof. Dr. Bayram KAYA
Assoc. Prof. Dr. M. Oğuzhan KILINÇEL
Assoc. Prof. Dr. İpek KÖSE TOSUNÖZ
Assoc. Prof. Dr. Burak MENEK
Assoc. Prof. Dr. Şamil ÖZTÜRK
Assoc. Prof. Dr. Ömer ŞEVGİN
Assoc. Prof. Dr. Derya TÜLLÜCE
Assoc. Prof. Dr. Sevda UZUN
Assoc. Prof. Dr. Yücel YILMAZ
Asst. Prof. Dr. Hasan Fatih AKGÖZ
Asst. Prof. Dr. Mustafa Ferit AKKURT
Asst. Prof. Dr. Ünal ALPAY
Asst. Prof. Dr. Meltem ASLAN
Asst. Prof. Dr. Numan ATILGAN
Asst. Prof. Dr. Tangül AYTUR ÖZEN
Asst. Prof. Dr. Sema BÜĞÜŞAN ORUÇ
Asst. Prof. Dr. Başak CAN
Asst. Prof. Dr. Sultan ÇAKMAK TANRIVER
Asst. Prof. Dr. Gülşah ÇAMCI
Asst. Prof. Dr. Ayseren ÇEVİK
Asst. Prof. Dr. Hülya DİĞER
Asst. Prof. Dr. Belgin DİLMEN
Asst. Prof. Dr. Gülşen FİLAZOĞLU ÇOKLUK
Asst. Prof. Dr. Aylar KARGAR MOHAMMADINAZHAD
Asst. Prof. Dr. Mustafa KAVAK
Asst. Prof. Dr. Aslı KAYA
Asst. Prof. Dr. Gizem KÖPRÜLÜLÜ KÜÇÜK
Asst. Prof. Dr. Özlem ÖZDEMİR
Asst. Prof. Dr. Rümeysa ÖZAYABAKAN
Asst. Prof. Dr. Alper PERÇİN
Asst. Prof. Dr. Azade SARI
Asst. Prof. Dr. Mine SEYYAH
Asst. Prof. Dr. Yunus ŞAHİNLER
Asst. Prof. Dr. Didem TETİK KÜÇÜKELÇİ
Asst. Prof. Dr. Engin YAVAŞ
Asst. Prof. Dr. Deniz YILDIZ
Asst. Prof. Dr. Yonca Güneş YÜCEL ATALAY
Lecturer Dr. Aysel TAMTAMIŞ KURT
Res. Asst. Dr. İsmail AYVAZ
Res. Asst. Dr. Ece GÜMÜŞOĞLU ACAR
Res. Asst. Dr. Berk KORKUT
Dr. SC Rozita TAMJIDIFAR
Dr. Sebla AK
Dr. Ramazan EMİRALİOĞLU
Dr. Hayrettin GÖÇMEN
Dr. Alp Giray KAYA
Dr. Sajjan PAL
Dr. Şeyma SÜNBÜL

Editörden

Merhaba,

“Sağlık Uygulamalarında Yapay Zekâ” IGUSABDER Özel Sayımızı sizlere söz verdiğimiz tarihte 2026 Temmuz ayında yayımladık. Bu bağlamda katkıda bulunan yazarlarımıza, hakemlerimize, tüm IGUSABDER ekibine sonsuz teşekkürlerimi sunuyorum. 2027 Temmuz ayında “Sağlıkta Dijital Etik ve Veri Yönetişi: Klinik, Teknolojik ve Toplumsal Boyutlar” başlığı ile çıkaracağımızı duyurduğumuz ikinci özel sayımıza gelen makalelerin süreci başladı. Gelecek olan makalelerde aynı özenle sizlere ulaştırılmak için hazırlanacak ve yine süresinde siz okurlarımıza ulaştırılmaya çalışılacak. Alt başlıklar konusunda 28. Sayımızda sizlere gerekli bilgilendirmeyi yapmıştım. Her sayımıza olduğu gibi bu sayımıza da katkılarınız ve desteğiniz bizi güçlendirecektir.

QS (QuacquarelliSymonds), "Avrupa Üniversiteleri Sıralaması 2026" sonuçlarını paylaştı. İstanbul Gelişim Üniversitesi (İGÜ), Avrupa genelinde ilk 500 üniversite arasına girerek akademik alandaki başarısını belgeledi. Güncel sonuçlara göre Türkiye'deki vakıf üniversiteleri arasında 4'üncü sıradaki yerini koruyan İGÜ, bilimsel araştırmaların etkisini ölçen “Makale Başına Atır” kategorisinde ise Avrupa genelinde 6'ncı oldu. İGÜ, aynı kategoride Türkiye genelinde ve vakıf üniversiteleri arasında 1'inci sırada yerini aldı. Times Higher Education (THE) tarafından açıklanan “Impact Ratings 2026” sonuçlarına göre İGÜ, sürdürülebilir kalkınma alanındaki yükselişini sürdürerek uluslararası başarılarına bir yenisini daha ekledi. Birleşmiş Milletler Sürdürülebilir Kalkınma Amaçları (SDG) doğrultusunda hazırlanan sıralamada İGÜ, geçen yıl yer aldığı 601-800 bandından 401-600 bandına yükselerek sürdürülebilirlik ilkeleri doğrultusunda tutarlı gelişimini bir kez daha gösterdi. Bu veri ile Türkiye'deki vakıf üniversiteleri arasında ilk üç üniversite arasına girmeyi başardı. Uluslararası yükseköğretim derecelendirme kuruluşu Times Higher Education (THE) tarafından açıklanan 2026 Dünya Üniversite Sıralaması sonuçlarına göre İGÜ, dünya genelinde 1001-1200 bandındaki yerini koruyarak, vakıf üniversiteleri arasında 9'uncu, Türkiye genelinde 16'ncı, Araştırma Kalitesi alanında ise Türkiye 2'ncisi oldu. Bu başarılarda emeği geçenlere teşekkür ediyorum.

Mustafa Kemal Atatürk 31 Ağustos 1925 tarihinde “Biz medeniyetten, ilim ve fenden kuvvet alıyoruz ve ona göre yürüyoruz. Başka bir şey tanımıyoruz” söyleminde bulunuyor. Bizlerde bu ilke doğrultusunda yürüyoruz. 30 Ağustos “Zafer Bayramımız kutlu olsun. Bir sonraki sayımızda buluşmak üzere sevgi ve saygılarımı sunuyorum.

Dr. Öğr. Üyesi A. Yüksel BARUT

Editör

From the Editor

Dear All,

We published our IGUSABDER Special Issue on “*Artificial Intelligence in Healthcare Applications*” in July 2026, as promised. In this regard, I would like to extend my sincere gratitude to all contributing authors, reviewers, and the entire IGUSABDER team. The submission and evaluation process has now begun for our second special issue, entitled “*Digital Ethics and Data Governance in Healthcare: Clinical, Technological, and Societal Dimensions*,” scheduled for publication in July 2027. All submitted manuscripts will be prepared for publication with the same care and diligence, and we will once again strive to deliver the issue to our readers on time. Further information regarding the subtopics was provided in Issue 28. As with every issue, your contributions and support will continue to strengthen us.

QS (Quacquarelli Symonds) has announced the results of the *QS Europe University Rankings 2026*. Istanbul Gelisim University (IGU) demonstrated its academic success by ranking among the top 500 universities in Europe. According to the latest results, IGU maintained its fourth-place position among foundation universities in Türkiye and ranked sixth in Europe in the “Citations per Paper” category, which measures the impact of scientific research. In the same category, IGU ranked first both among all universities in Türkiye and among foundation universities. According to the *THE Impact Rankings 2026*, announced by Times Higher Education (THE), IGU continued its upward trajectory in sustainability, adding another achievement to its international accomplishments. In the rankings based on the United Nations Sustainable Development Goals (SDGs), IGU rose from the 601–800 band last year to the 401–600 band, once again demonstrating its consistent progress in line with sustainability principles. With this result, it succeeded in ranking among the top three foundation universities in Türkiye. According to the *Times Higher Education World University Rankings 2026*, IGU maintained its position in the 1001–1200 band worldwide. It ranked ninth among foundation universities and sixteenth overall in Türkiye, while placing second in Türkiye for Research Quality. I would like to thank everyone whose efforts contributed to these achievements.

On 31 August 1925, Mustafa Kemal Atatürk stated: “*We draw our strength from civilization, science, and knowledge, and we proceed accordingly. We recognize no other path.*” We, too, continue to move forward in accordance with this principle. Happy Victory Day on 30 August.

We look forward to welcoming you again in our next issue.

With warm regards,

Asst. Prof. A. Yüksel BARUT

Editor



**Sağlık Bilimleri
Fakültesi**

İstanbul Gelişim Üniversitesi, Sağlık Bilimleri Fakültesi'nin aşağıdaki Bölümleri,
Almanya merkezli **Accreditation Agency in Health and Social Sciences /
Akkreditierungsagentur im Bereich Gesundheit und Soziales (AHPGS)**
tarafından

**Beslenme ve Diyetetik (TR-İNG),
Fizyoterapi ve Rehabilitasyon (TR-İNG),
Hemşirelik (TR-İNG)** bölümleri 2030 yılına kadar;

**Çocuk Gelişimi (TR-İNG),
Ergoterapi,
Odyoloji,
Sağlık Yönetimi,
Sosyal Hizmet (TR-İNG)** bölümleri 2018-2023 yılları arasında
koşulsuz olarak akredite edilmiştir.

&

*The Following Departments of Istanbul Gelisim University, Faculty of Health Sciences
have been unconditionally accredited by the Germany based **Accreditation Agency
in Health and Social Sciences / Akkreditierungsagentur im Bereich
Gesundheit und Soziales (AHPGS)***

***Nutrition and Dietetics (Turkish-English Tracks)
Physical Therapy and Rehabilitation (Turkish-English Tracks),
Nursing (Turkish-English Tracks)*** departments until 2030;

***Audiology,
Child Development (Turkish-English Tracks),
Health Management,
Occupational Therapy,
Social Service (Turkish-English Tracks)*** departments were accredited
unconditionally between 2018-2023.

İÇİNDEKİLER / CONTENTS

	Sayfa/Page
<i>Editörden</i>	x
<i>From the Editor</i>	xi
<i>İçindekiler / Contents</i>	xiii

Özgün Araştırma Makaleleri (Original Research Articles)

Nephroprotective Effect of Apilarnil in Acetaminophen-Induced Acute Kidney Injury Model	399-410
<i>Asetaminofen ile İndüklenen Akut Böbrek Hasarı Modelinde Apilarnilin Nefroprotektif Etkisi</i>	
Nucan BIÇAKÇI, Sercan BIÇAKÇI, İhsan KARABOĞA	
Integrated MRI-Derived, Pathologic, and Molecular Biomarkers for Prediction of Neoadjuvant Chemotherapy Response in Breast Cancer	411-425
<i>Meme Kanseri Neoadjuvan Kemoterapi Yanıtının Öngörülmesinde MRG Tabanlı, Patolojik ve Moleküler Biyobelirteçler</i>	
Mehmet Ali NAZLI, Melis BAYKARA ULUSAN, Fadime Didem TRABULUS, Rıza Umar GÜRSU, Emel ESMERER, Esra Canan KELTEN TALU	
Effect of miR-105-5p on Cell Proliferation, Colony Formation, and hTERT/P53/P21 Gene Expression in Multiple Cancer Cell Lines	426-444
<i>miR-105-5p'nin Çeşitli Kanser Hücre Hatlarında Hücre Proliferasyonu, Koloni Oluşumu ve hTERT/P53/P21 Gen Ekspresyonuna Etkisi</i>	
Aylin ÖRS, Hamide DOĞAN, Eylem NAS, Aycan SEZAN, Mehmet Yağız ÇAPANOĞLU, Taoufik ALLABABİDİ, Burcu SAYGIDEĞER, Yasemin SAYGIDEĞER	
Hypertension-Related Microstructural Changes in the Vitreous Humor Detected by Diffusion MRI	445-462
<i>Hipertansiyon ile İlişkili Vitreus Humerusta Mikroyapısal Değişikliklerin Difüzyon MRG ile Değerlendirilmesi</i>	
Davut Ünsal ÇAPKAN	
Prediction of Arsenic and Cadmium Intoxication Cases from <i>Lucilia Sericata</i> (Meigen, 1826) [Diptera: Calliphoridae] Larvae by ICP-MS	463-479
<i>ICP-MS ile <i>Lucilia Sericata</i> (Meigen, 1826) [Diptera: Calliphoridae] Larvalarından Arsenik ve Kadmiyum İntoksikasyon Olgularının Tahmini</i>	
Çağdaş ADIÖREN, Selda MERCAN, Murat YAYLA, Sümeyye Zülal ŞİMŞEK DURAN, Erdal POLAT	

- In Silico* Functional Assessment of COL4A3, COL4A4, and COL4A5 SNPs in Alport Syndrome** 480-499
Alport Sendromunda COL4A3, COL4A4 ve COL4A5 SNP'lerinin İn Silico Fonksiyonel Değerlendirilmesi
 Beyza Rümeysa ERGİNAL GEÇ, Tuğba KAMAN, Mesut KARAHAN
- Telemedicine Research Trends: A Bibliometric Perspective on Security and Privacy** 500-521
Tele-tıp ve Veri Güvenliğinin Kesişimi: Kapsamlı Bir Bibliyometrik Analiz
 Binnur AKIF, Nesrin KOLUKIRIK, Sinem BÜYÜKSAATÇI KİRİŞ
- A Bibliometric Analysis of Surgical Site Infections in Pediatric Surgery** 522-532
Pediyatrik Cerrahide Cerrahi Alan Enfeksiyonları Üzerine Bibliyometrik Analiz
 Aydın NART, Meltem ASLAN
- Comparison of the Effectiveness of Schroth Exercise Method and Combined (Manual Therapy + Schroth Exercise Method) Method in Idiopathic Adolescent Scoliosis** 533-548
İdiyopatik Adölesan Skolyozda Schroth Egzersiz Yöntemi ile Kombine (Manuel Terapi+ Schroth Egzersiz Yöntemi) Yöntemin Etkinliğinin Karşılaştırılması
 Seyyede Sahra KARIMI, Ömer ŞENEL
- Health Perceptions and Attitudes Toward Cancer Screenings Among Individuals Attending Family Health Centers: A Cross-Sectional Research** 549-563
Aile Sağlığı Merkezine Başvuran Bireylerin Sağlık Algıları ve Kansere Taramalarına Yönelik Tutumları
 Dilek YILDIRIM, Ferda AKYÜZ ÖZDEMİR, İbrahim Halil BOYACI
- The Mediating Role of Self-Esteem in the Effect of Muscle Dysmorphia on Exercise Dependence** 564-577
Kas Dismorfisinin Egzersiz Bağımlılığına Etkisinde Benlik Saygısının Aracı Rolü
 Aydan AKKURT YALÇINTÜRK, Ahmet Kamil YILMAZ, İrem İclal KARADAŞ
- Death Anxiety Among Nursing Students After the February 6 Turkey Earthquake: The Role of Earthquake Fear and Religious Coping** 578-597
6 Şubat Türkiye Depreminden Etkilenen Hemşirelik Öğrencilerinde Deprem Korkusunun Ölüm Kaygısı Üzerindeki Etkisi: Dini Başa Çıkmanın Aracı Rolü
 Seher ÇEVİK AKTURA, Semiha DERTLİ, Askeri ÇANKAYA
- From Pixels to Isolation: The Role of Game Type in the Connection between Video Game Addiction and Loneliness** 598-613
Piksellerden İzolasyona: Video Oyunu Bağımlılığı ve Yalnızlık Arasındaki İlişkide Oyun Türünün Rolü
 Abdullah ATLI, Sertan Hamza GÜR, Yeliz YAZICI DEMİR

- The Association between Synthetic Oxytocin Administration During Labor and Birth Interventions, Maternal Anxiety, and Newborn Stress Levels: A Comparative Study** 614-629
Doğum Eylemi Sırasında Sentetik Oksitosin Uygulaması ile Doğum Müdahaleleri, Maternal Kaygı ve Yenidoğan Stres Düzeyleri Arasındaki İlişki: Karşılaştırmalı Bir Çalışma
Hatice Gül ÖZTAŞ, Esra SABANCI BARANSEL, Melek Nur KEÇELİ
- The Use of Physician Rating Sites and Their Impact on Physician Preference** 630-644
Hekim Derecelendirme Sitelerinin Kullanımı ve Hekim Tercihine Etkisi
Aslı METİN
- Association of Embryology Education with Infertility Knowledge and Attitudes among Medical and Health Sciences Students** 645-664
Tıp ve Sağlık Bilimleri Öğrencileri Arasında Embriyoloji Eğitimi ile Kısırlık Konusundaki Bilgi ve Tutumlar Arasındaki İlişki
Emrah ZAYMAN, Feyza İNCEOĞLU
- Association between Health Information Obtained via Social Media and Eating Attitudes: A Descriptive and Correlational Study** 665-680
Sosyal Medya Aracılığıyla Elde Edilen Sağlık Bilgilerinin Yeme Tutumları Arasındaki İlişki: Tanımlayıcı ve İlişki Arayıcı Bir Çalışma
Halil İbrahim BİLKAY, Esra ÜNAL, Ayşenur DEMİR KÜÇÜKKÖSELER
- Screen Exposure, Circadian Rhythm, Sleep, Physical Activity, and Health Anxiety in University Students During Online Education** 681-694
Çevrim İçi Eğitim Döneminde Üniversite Öğrencilerinde Ekran Maruziyeti, Sirkadiyen Ritim, Uyku, Fiziksel Aktivite ve Sağlık Anksiyetesi
Sümeyye AKÇAY, Mehmet Burak UYAROĞLU, Gamze KOYUTÜRK, Zuhale KUNDURACILAR, Emre Serdar ATALAY, Burcu AKKURT
- Associations of Diet Quality and Body Composition with Sleep Quality in Professional Athletes: A Cross-Sectional Study** 695-710
Profesyonel Sporcularda Diyet Kalitesi ve Vücut Kompozisyonunun Uyku Kalitesi ile İlişkisi: Kesitsel Bir Çalışma
Göksu ŞEN POLAT, Merve YILMAZ
- Evaluation of Vegetarian and Vegan Menus Served in University Cafeterias in Terms of Nutritional Value** 711-722
Üniversite Yemekhanelerinde Sunulan Vejetaryen ve Vegan Menülerin Besin Değeri Açısından Değerlendirilmesi
Bahar YALÇIN ÇELİKTAŞ, Muazzez GARİPAĞAOĞLU, İlayda KOÇAK, Misline GEYİK

Evaluation of the Relationships between International Students' Levels of Adaptation to Turkish Cuisine and Anthropometric Measurements: An Analytical Cross-Sectional Research 723-735

Uluslararası Öğrencilerin Türk Mutfağına Uyum Düzeyleri ve Antropometrik Ölçümleri Arasındaki İlişkilerin Değerlendirilmesi: Analitik Kesitsel Çalışma
Şule ARSLAN, Can ERGÜN, Elif Gülfem KİRAZ

Effectiveness of Aerobic Exercise–Based Interventions in Children Exposed to Sexual Abuse 736-749

Cinsel İstismara Maruz Kalan Çocuklarda Aerobik Egzersize Dayalı Müdahalelerin Etkinliği
Tuğçe BİLGİÇ, Ali KARAAĞAÇ, Caner MUTLU, Ebru KAYA MUTLU

The Relationship between Trust in Nurses and Medication Adherence Among Individuals with Chronic Illnesses 750-767

Kronik Hastahğı Olan Bireylerde Hemşirelere Duyulan Güven ile İlaç Uyumu Arasındaki İlişki
Nadiye BARIŞ EREN

The Role of Socio-Demographic Characteristics in Physicians' Attitudes Towards Artificial Intelligence 768-783

Hekimlerin Yapay Zekaya Karşı Tutumlarında Demografik Özelliklerin Rolü
Erhan BIYIK

Artificial Intelligence Addiction, Technostress, and Work-Life Balance Among Academics: An Employee Health Perspective 784-802

Akademisyenlerde Yapay Zeka Bağımlılığı, Teknostres ve İş Yaşam Dengesi: Çalışan Sağlığı Perspektifi
Raife AŞIK, Nida EFETÜRK, Fatoş TOZAK

The Relationship between Nurses' Work Environment Characteristics, Job Performance and Patients' Satisfaction with Nursing Care 803-816

Hemşirelerin Çalışma Ortamı Özellikleri ve İş Performansı ile Hastaların Bakım Memnuniyeti Arasındaki İlişki
Filiz ÖZBEY, Betül SÖNMEZ

Derleme Makaleler (Review Articles)

Classification of Ethical Dilemmas in Medical Social Work: A Conceptual Evaluation through Case Examples of Conflicting Values 817-836

Tıbbi Sosyal Hizmette Etik İkilemlerin Sınıflandırılması: Çatışan Değerler Arasında Vaka Örnekleri Üzerinden Kavramsal Bir Değerlendirme
Gizem ÇELİK ÖZKAN

Individual Resilience and Protective Mental Health: The Role of Psychological Resilience	837-847
<i>Bireysel Dayanıklılık ve Koruyucu Ruh Sağlığı: Psikolojik Sağlamlığın Rolü</i> Nurten ELKİN, Ayşe Mücella SOYDAN	
The Role of Nutrition Therapy in the Management of Chronic Pain	848-866
<i>Kronik Ağrı Yönetiminde Beslenme Tedavisinin Rolü</i> Hatice Tuğçe BERBEROĞLU, Muteber Gizem KESER GÜMÜŞ	
The Role of Telerehabilitation-Based Exercises in the Management of Knee Osteoarthritis: A Narrative Review	867-880
<i>Diz Osteoartriti Yönetiminde Telerehabilitasyon Yoluyla Uygulanan Egzersizlerin Rolü: Bir Anlatı İncelemesi</i> Yaşar Sinan KAYA, Hüsniye Merve DEMİNER	
The Relationship of Temperament and Character with Substance Use	881-892
<i>Mizaç ve Karakter ile Madde Kullanımı İlişkisi</i> Ünal Erdem ELLİ	
<i>IGUSABDER Article Writing Rules</i>	

Nephroprotective Effect of Apilarnil in Acetaminophen-Induced Acute Kidney Injury Model

Nucan BIÇAKÇI*, Sercan BIÇAKÇI**, İhsan KARABOĞA***

Abstract

Aim: High-dose and long-term acetaminophen (paracetamol; PAR) use can cause acute and chronic kidney damage. It was reported that apilarnil (AP), an apitherapy product obtained from drone larvae, has high antioxidative and anti-inflammatory effects. In this study, the effect of apilarnil on kidney tissue damage, oxidative status, and inflammation in an acetaminophen-induced renal injury model was investigated.

Method: A total of 32 adult male Wistar albino rats were used in this study. Rats were divided into 4 groups as control, paracetamol (PAR), paracetamol+apilarnil (PAR+AP) and apilarnil (AP) groups. A dose of 600 mg/kg PAR was used to create the acute kidney injury model. AP was administered at a dose of 0.8 mg/kg. Kidney tissue histopathology was evaluated with the hematoxylin-eosin (H&E) staining method. Renal tumor necrosis factor α (TNF- α) expression was determined by the indirect immunohistochemical method. Renal glutathione peroxidase (GPx), superoxide dismutase (SOD), catalase (CAT) and malondialdehyde (MDA) levels were determined by the ELISA method.

Results: PAR administration caused an increase in MDA level in kidney tissue, while antioxidant enzyme levels of SOD, CAT and GPx decreased. PAR also caused an increase in renal TNF- α immunohistochemical expression. AP treatment provided a significant decrease in MDA level, while GPx and SOD levels increased. AP treatment also provided a decrease in renal TNF- α expression and tubular damage score.

Conclusion: This study is the first report showing that AP prevents paracetamol-induced renal damage. AP may be an option that can be used for the treatment of high-dose paracetamol-induced renal damage.

Keywords: Acetaminophen, apilarnil, acute kidney injury.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 20.02.2025 **Kabul / Accepted:** 29.07.2026

DOI: <https://doi.org/10.38079/igusabder.1643639>

* Asst. Prof. Dr., Tekirdağ Namık Kemal University, Faculty of Medicine, Department of Internal Medicine, Tekirdağ, Türkiye. E-mail: nbicakci@nku.edu.tr [ORCID https://orcid.org/0000-0003-1358-9224](https://orcid.org/0000-0003-1358-9224)

** Asst. Prof. Dr., Tekirdağ Namık Kemal University, Faculty of Medicine, Department of Emergency Medicine, Tekirdağ, Türkiye. E-mail: sbicakci@nku.edu.tr [ORCID https://orcid.org/0000-0002-3268-0499](https://orcid.org/0000-0002-3268-0499)

*** Asst. Prof. Dr., Kırklareli University, Faculty of Medicine, Department of Histology and Embryology, Kırklareli, Türkiye. E-mail: ihsankaraboga@gmail.com ; ihsankaraboga@klu.edu.tr [ORCID https://orcid.org/0000-0001-6708-1229](https://orcid.org/0000-0001-6708-1229)

ETHICAL STATEMENT: This study was carried out with the approval of the Ethics Committee of Tekirdağ Namık Kemal University, dated 14/03/2024 and numbered 2.

Asetaminofen ile İndüklenen Akut Böbrek Hasarı Modelinde Apilarnilin Nefroprotektif Etkisi

Öz

Amaç: Yüksek doz ve uzun süre Asetaminofen (parasetamol) kullanımı akut ve kronik böbrek hasarına neden olabilmektedir. Erkek arı larvasından elde edilen bir apiterapik ürün olan apilarnilin, yüksek antioksidatif ve antiinflamatuvar etkilere sahip olduğu belirtilmiştir. Bu çalışmada asetaminofen-uyarımlı renal hasar modelinde apilarnilin böbrek doku hasarı, oksidatif statü ve inflamasyon üzerindeki etkisi incelendi.

Yöntem: Çalışmada 32 adet erişkin erkek Wistar albino sıçan kullanıldı. Sıçanlar kontrol, parasetamol (PAR), parasetamol+apilarnil (PAR+AP) ve apilarnil (AP) olarak 4 gruba ayrıldı. Akut böbrek hasar modeli oluşturmada 600 mg/kg PAR kullanıldı. AP 0,8 mg/kg dozda uygulandı. Böbrek doku histopatolojisi hematoxilen – eozin (H&E) boyama yöntemi ile değerlendirildi. Renal TNF- α ifadesi indirekt immünohistokimyasal yöntemle belirlendi. Renal glutatyon peroksidaz (GPx), süperoksit dismutaz (SOD), katalaz (CAT) ve Malondialdehit (MDA) seviyeleri ELISA yöntemi ile belirlendi.

Bulgular: PAR uygulaması böbrek dokusunda MDA seviyesinde artışa neden olurken; antioksidan enzimler SOD, CAT ve GPx seviyelerinde azalmaya neden oldu. Ayrıca PAR, renal TNF- α immünohistokimyasal ifadesinde artışa neden oldu. AP tedavisi MDA seviyesinde anlamlı bir azalma sağlarken, GPx ve SOD seviyesinde artış sağladı. Ayrıca AP uygulaması renal TNF- α ifadesi ve tübüler hasar skorunda azalma sağladı.

Sonuç: Araştırmamız AP'nin parasetamol-uyarımlı renal hasarı engellediğini gösteren ilk rapordur. AP, yüksek doz parasetamol kaynaklı renal hasarın tedavisinde kullanılabilecek alternatif bir seçenek olabilir.

Anahtar Sözcükler: Asetaminofen, apilarnil, akut böbrek hasarı.

Introduction

Acetaminophen (paracetamol; PAR) is one of the most commonly used antipyretic (fever reducer)-analgesic (pain reliever) drugs in many countries, and is available without a prescription¹. It is widely used for many ailments such as colds, sore throat, muscle-joint pain, and toothache². Easy access and widespread use also lead to the risk of toxicity^{3,4}. Experimental and clinical studies showed that PAR causes liver and kidney damage when used in high doses⁵⁻⁷. Kidneys have important physiological functions such as homeostasis, endocrine functions, acid-base and electrolyte balance⁸. The liver and kidneys are known to be more sensitive to toxic substances and are exposed to more toxicity compared to other organs⁹. PAR is mostly detoxified in the liver by conjugation with glucuronic acid. About 5% of the ingested PAR dose undergoes N-hydroxylation in the liver with the participation of cytochrome P450 enzymes (especially CYP2E1) and a very rapid toxic metabolite, N-acetyl-p-benzoquinone imine (NAPQI), is formed^{9,10}. This metabolite is a highly reactive compound that is excreted in urine. High doses of PAR cause overproduction of NAPQI and the level of NAPQI may exceed the detoxification capacity of glutathione (GSH). In addition, PAR is converted to p-aminophenol, a nephrotoxic metabolite, by deacetylation in the renal cortex. NAPQI and p-aminophenol produced during chronic use and by high doses of paracetamol cause kidney damage^{11,12}.

It was reported that excessive PAR intake causes vasoconstriction in the kidneys and a decrease in glomerular filtration rate^{13,14}. It was also suggested that GSH reduction and oxidative stress are important factors in nephrotoxicity caused by high-dose paracetamol intake¹⁵. Previous studies reported that acute high-dose PAR administration increases lipid peroxidation and weakens antioxidant mechanisms in kidney tissue^{16,17}. Although N-acetyl cysteine, which is used to alleviate PAR toxicity in clinics, prevents liver toxicity, it does not protect against kidney damage¹⁸. There is a need for new agents that are safe and have low toxicity risk and can be used as alternatives for PAR-induced kidney damage.

Apilarnil (AP), a current apitherapy agent with high antioxidant and anti-inflammatory properties, is a product obtained from drone larvae¹⁹. Elashal et al. (2024) reported that apilarnil prevents tissue damage by reducing the level of malondialdehyde (MDA) in testicular tissue against bisphenol-A (BPA) toxicity²⁰. Another study demonstrated that AP treatment significantly reduced the levels of the proinflammatory cytokines interleukin-1 beta (IL-1B), tumor necrosis factor alpha (TNF- α), and nuclear factor kappa beta (Nf-kB), while also preventing liver tissue damage in a lipopolysaccharide (LPS)-induced liver injury model²¹. In the current study, we intend to examine the kidney protective effects of AP in a PAR-induced rat nephrotoxicity model for the first time in the literature by determining histopathological, immunohistochemical, and tissue oxidative status.

Material and Methods

Chemicals

Parol (paracetamol 500 mg, Parol, Atabay Drug Industries, Turkey) was used to create the nephrotoxicity model. Apilarnil was purchased from Nutral Therapy (Erciyes University Technopark, Kayseri, Türkiye).

Experimental Model

The experimental investigations were conducted at Namık Kemal University Experimental Animal Research Center. During the experimental period, animals were fed with standard pellet diet and tap water ad libitum in a standard laboratory environment (40-60% humidity, 22 $\pm$ 2°C, and 12:12 h dark-light cycle).

Thirty-two adult male Wistar albino rats (200-240 g, 8 weeks old) were used in the study. Rats were divided into 4 groups (n=8); Control, PAR, PAR+AP and AP. Nephrotoxicity induction was performed by i.p. administration of PAR (dissolved in 1 ml physiological serum) at a dose of 600 mg/kg²². AP was administered by oral gavage at a dose of 0.8 mg/kg (dissolved in 1 ml of physiological serum)²¹. At the end of the 24th hour following PAR administration, rats were sacrificed by taking blood from the heart under ketamine-xylazine anesthesia. Kidney tissues were fixed with buffered neutral formalin for histological examination. The tissues were kept at -80°C for oxidative stress status analysis.

Histochemical Examinations

After 48 hours of fixation at room temperature, kidney tissues were washed with running tap water overnight. The tissues cleared of formalin were passed through graded ethanol (70-80-90 and 100%) for dehydration and cleared in toluene. Then, they were waxed in paraffin. The obtained tissue blocks were cut to 4-5 µm thick using a semi-motorized microtome (Leica RM-2245). To examine the histopathology of kidney tissue, sections were stained with hematoxylin-eosin (H&E). Tubular damage caused by paracetamol in kidney tissue was scored according to Ban et al. (2022)²³. Accordingly, scoring was 0, no damage; 1, 1-10% damaged area; 2, 11-25% damaged area; 3, 26-75% damaged area; and 4, 75% or more damaged area.

Renal TNF-α Immunoreactivity

Renal TNF-α immunohistochemical labeling was determined with the indirect immunohistochemical method. Sections deparaffinized with xylene were dehydrated in a graded ethanol series and washed with phosphate buffer (PBS). The antigen retrieval step was performed by boiling in citrate buffer. Sections were treated with hydrogen peroxide (3%, aqueous H₂O₂ solution) for endogenous peroxide suppression. Slides rinsed with PBS were treated with block serum for 60 min and then treated with TNF-α antibody (TNF-α, 1:100 dilution, Elabsience) in a humid chamber for 90 min at 37 °C in an oven. 3-aminoethyl carbazole (AEC) was applied as a chromogen to the sections labeled with biotin and streptavidin antibodies, respectively. Background staining was performed with Mayer's hematoxylin. TNF-α staining intensity in the sections was evaluated according to Carter et al. (2004) (staining distribution 0.1, <25%; 0.4, 26–50%; 0.6, 51–75%; 0.9, 76–100% and staining intensity 0; no staining, 0.5; very little staining, 1; little staining, 2; moderate staining, 3; very strong staining). Immunohistochemical staining score = distribution x intensity²⁴.

Tissue Oxidative Stress Parameters

Levels of lipid peroxidation marker malondialdehyde (MDA) and the antioxidant enzymes catalase (CAT), glutathione peroxidase (GPx), and superoxide dismutase (SOD) in kidney tissue were determined by the sandwich ELISA method using the procedures for the relevant commercial kit (MDA, SH0020; GPx, E1172Ra; SOD, SH0039; CAT, E0869Ra, BT Lab, Bioassay Technology Laboratory).

Ethical Statement

This study was carried out with the approval of the Ethics Committee of Tekirdağ Namık Kemal University, dated 14/03/2024 and numbered 2.

Statistical Analyses

Analysis of data was conducted using SPSS (SPSS, IBM, Version 21, USA) and GraphPad Prism 8 software. Data are expressed as mean ± standard deviation value. Values were

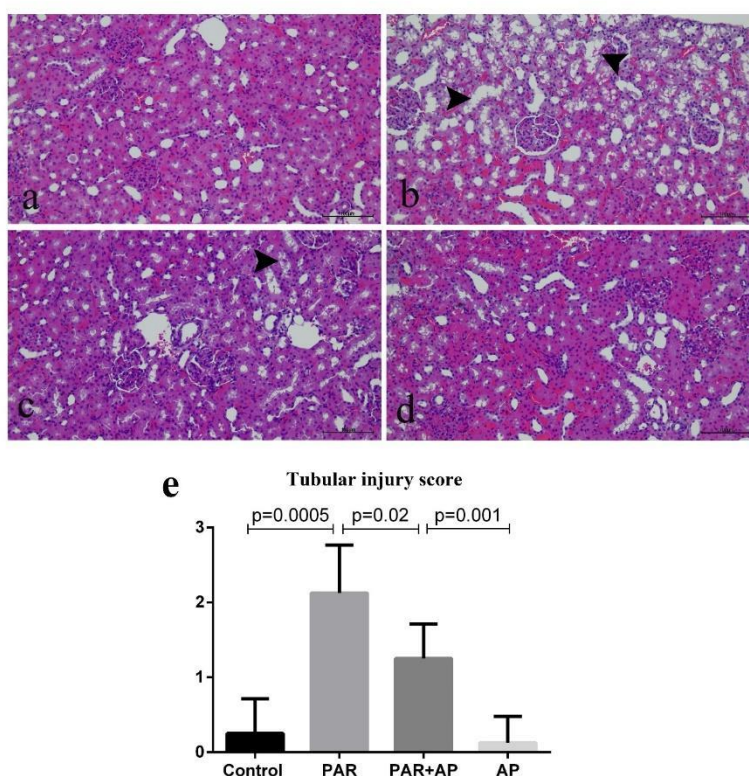
evaluated using a non-parametric test (Kruskal-Wallis). The significance of the values obtained in the groups after two-way comparisons was measured with the Mann-Whitney U test. A difference between groups was considered statistically significant if it was less than 0.05.

Results

AP Improved PAR-Induced Renal Histopathology

Kidney tissue histopathological findings are presented in Figure 1. The kidney structure in the control group was found to be normal. Degeneration and hemorrhage in tubular epithelial cells were detected in the PAR group. In the AP-treated group, tubular morphology was observed to be closer to normal compared to the nephrotoxicity group. The group only given AP had normal architecture of kidney tissue. Tubular damage scores for the groups are presented in Figure 1-e. The tubular damage score was significantly increased in the PAR group compared to the control group. In the PAR+AP group, the tubular damage score was significantly decreased compared to the PAR group.

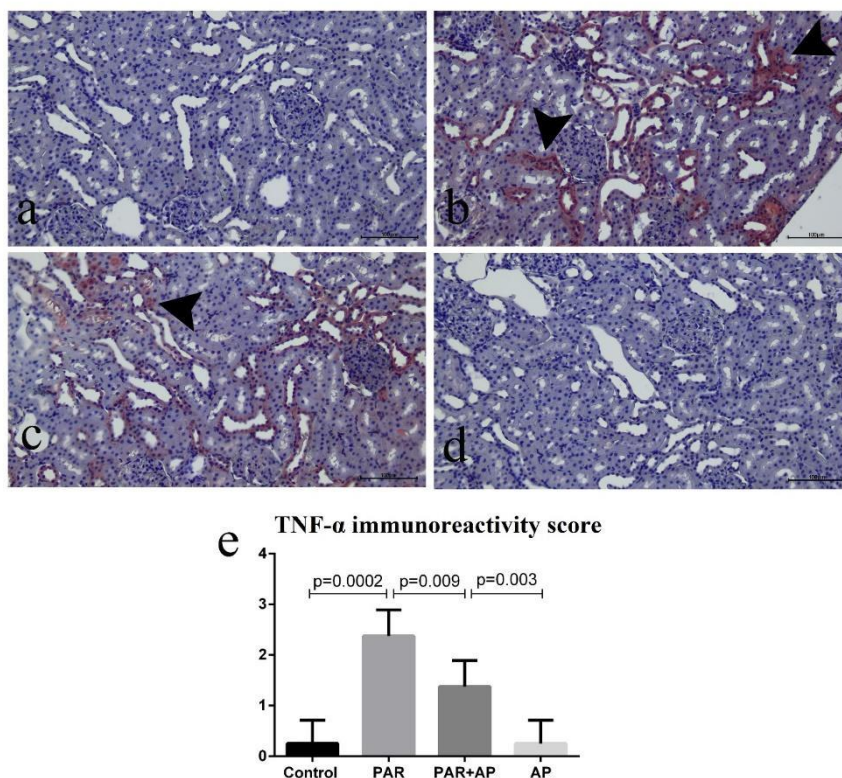
Figure 1. The effect of AP on PAR-induced acute renal injury. a; control, b; PAR, c; PAR+AP, d; AP, e; tubular injury scores of groups, (arrowhead; tubular epithelial shrinking, dye; hematoxylin and eosin, magnification; 200x)



AP Alleviated Renal TNF- α Expression

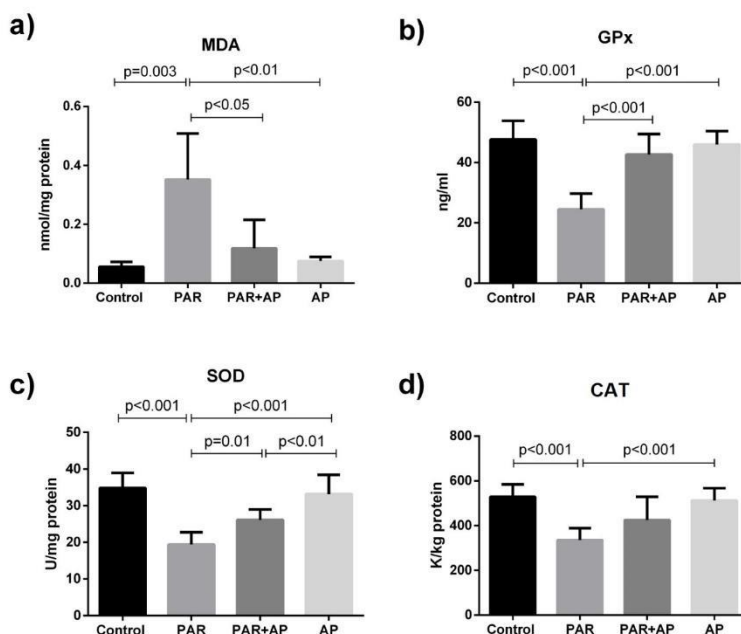
Figure 2 shows the immunohistochemical expression of TNF- α in kidney tissue. TNF- α expression was concentrated especially in tubular epithelial cells in kidney tissue. AP treatment provided a significant decrease in TNF- α immunohistochemical expression.

Figure 2. Effect of AP on renal TNF- α immunoreactivity, a; control, b; PAR, c; PAR+AP, d; AP, e; TNF- α immunoreactivity scores for the groups (arrowhead; TNF- α positive cells, magnification; 200x, counterstain; Mayers hematoxylin)



Oxidative Status Findings

Figure 3 displays the MDA, SOD, CAT, and GPx results for the groups. MDA levels were significantly higher in the PAR group compared to the control group. MDA levels decreased in the PAR+AP group compared to the PAR group. SOD, CAT and GPx levels decreased significantly in the PAR group compared to the control group. GPx and SOD levels increased significantly in the PAR+AP group compared to the PAR group.

Figure 3. Effect of AP on MDA, GPx, SOD and CAT enzyme levels

Discussion

The beneficial effects of products obtained through beekeeping, such as honey, propolis, pollen, royal jelly, and bee bread, have been known by people for a long time, and these products are used for various purposes²⁵. The role of apilarnil, an apitherapy product that is becoming popular around the world in recent years, in PAR-induced nephrotoxicity was examined for the first time in this study.

High doses of PAR, one of the most common painkillers sold without a prescription, can cause liver and kidney damage³. The frequency of nephrotoxicity due to high-dose PAR use was reported as 2-10% in the literature²⁶. The fact that kidney damage can develop without signs of liver damage due to PAR use makes the issue more remarkable²⁷. Several natural products and phytochemicals were reported to alleviate the PAR-induced hepatorenal toxicity to date^{2,28,29}.

In the pathogenesis of PAR-induced renal damage, inadequacy of GSH capacity to detoxify the increased production of NAPQI plays an important role³⁰. For this reason, GSH stands out as a key parameter in studies examining acetaminophen-induced renal damage in the literature^{31,32}. Canayakin et al. reported decreased GSH levels in a PAR-induced renal damage model³². In this study, AP treatment significantly increased the decreased GSH-px level caused by PAR. In PAR-induced renal damage models, various agents used for therapeutic purposes were reported to increase GSH levels and improve oxidative damage markers and renal histopathology^{16,33}. Oxidative stress also contributes to tissue damage in PAR-induced nephrotoxicity³⁴. Tissue damage may be aggravated due to the increase in free radicals due to the increase in NAPQI and the decrease in

enzymes that have antioxidant effects such as SOD and CAT, especially due to GSH depletion^{33,35}. In this study, a significant decrease in SOD and CAT enzyme levels was determined together with GPx in the PAR group. In line with previous literature, MDA, an important marker of tissue damage, was found to be significantly higher in the PAR group. Experimental studies reported the positive effects of natural agents containing various polyphenolic compounds in the suppression of PAR-induced renal damage and oxidative stress^{29,36}. AP, which contains many phenolic and polyphenolic components in its structure, has high antioxidant and radical scavenging properties in experimental studies^{25,37,38}. Doganyigit et al. (2020) reported that AP treatment provided significant improvements in MDA, SOD and CAT enzyme levels in the LPS-induced sepsis model. Elashal et al. (2024) reported that AP treatment prevented tissue damage along with improvements in testicular MDA and GSH levels in a BPA-induced testicular injury model²⁰. In line with the aforementioned studies, AP administration alleviated the severity of tissue damage by providing a significant increase in the oxidative stress parameters of SOD and GPx. Unlike these studies, CAT level increased in the PAR+AP group, but it was not found to be statistically significant. In previous studies, the role of inflammation in the pathogenesis of PAR-induced nephrotoxicity was reported^{27,28}. Following high-dose PAR application, increased TNF- α levels activate the inflammatory cascade in kidney tissue, causing the release of proinflammatory cytokines¹⁸. El-Boshy et al. (2019) and Ozatik et al. (2019) reported TNF- α levels in a PAR-induced acute kidney injury model^{17,39}. In line with the aforementioned studies, increased TNF- α levels in kidney tissue were shown immunohistochemically in the present study. AP treatment provided a significant decrease in TNF- α levels. Inandiklioğlu et al. (2021) reported that AP administration provided a significant decrease in TNF- α levels in the LPS-induced renal injury model⁴⁰.

This study has some limitations. In this study, BUN and creatinine levels, which are biochemical markers of renal injury, could not be determined. In addition, the findings are valid for the experimental model in this study and lack clinical data. In order to better elucidate the role of AP in PAR-induced renal injury, further studies are needed using advanced methods with different doses and durations.

Conclusion

In conclusion, we determined that AP administration suppressed the inflammatory cascade in a PAR-induced acute renal injury model and protected the tissue structure by preventing oxidative damage. We think that AP can be used as a potential product for the treatment of high-dose PAR-induced renal injury.

REFERENCES

1. Budnitz DS, Lovegrove MC, Crosby AE. Emergency department visits for overdoses of acetaminophen-containing products. *American Journal of Preventive Medicine*. 2011;40(6):585-592.

2. Singh DP, Mani D. Protective effect of Triphala Rasayana against paracetamol-induced hepato–renal toxicity in mice. *Journal of Ayurveda and Integrative Medicine*. 2015;6(3):181.
3. Çoban FK, İnce S, Demirel HH, İslam İ, Aytuğ H. Acetaminophen-induced nephrotoxicity: suppression of apoptosis and endoplasmic reticulum stress using boric acid. *Biological Trace Element Research*. 2023;201(1):242-249.
4. Lewis RK, Paloucek FP. Assessment and treatment of acetaminophen. *Clin Pharm*. 1991;10:765-774.
5. Oksuz E, Yasar S, Erten R, Arihan O, Oto G. Comparison of effects of high and low dose paracetamol treatment and toxicity on brain and liver in rats. *Northern Clinics of İstanbul*. 2020;7(6).
6. Chidiac AS, Buckley NA, Nogrehchi F, Cairns R. Paracetamol (acetaminophen) overdose and hepatotoxicity: mechanism, treatment, prevention measures, and estimates of burden of disease. *Expert Opinion on Drug Metabolism & Toxicology*. 2023;19(5):297-317.
7. Khan Z, Abumedian M, Ibekwe M, Musa K, Mlawa G. Acute renal impairment in patients due to paracetamol overdose in the absence of hepatic impairment. *Cureus*. 2021;13(12).
8. Aktas Senocak E, Utlu N, Kurt S, Kucukler S, Kandemir FM. Sodium pentaborate prevents acetaminophen-induced hepatorenal injury by suppressing oxidative stress, lipid peroxidation, apoptosis, and inflammatory cytokines in rats. *Biological Trace Element Research*. 2023;1-10.
9. Burcham PC. Target-organ toxicity: liver and kidney. *An Introduction to Toxicology*. 2014:151-187.
10. Hazai E, Vereczkey L, Monostory K. Reduction of toxic metabolite formation of acetaminophen. *Biochemical and Biophysical Research Communications*. 2002;291(4):1089-1094.
11. Gharishvandi F, Kazerouni F, Ghanei E, Rahimipour A, Nasiri M. Comparative assessment of neutrophil gelatinase-associated lipocalin (NGAL) and cystatin C as early biomarkers for early detection of renal failure in patients with hypertension. *Iranian Biomedical Journal*. 2015;19(2):76.
12. Dua TK, Palai S, Roy A, Paul P. Protective effect of probiotics against acetaminophen induced nephrotoxicity. *Molecular Biology Reports*. 2022;49(8):8139-8143.

13. Kanchanasurakit S, Arsu A, Siriplabpla W, Duangjai A, Saokaew S. Acetaminophen use and risk of renal impairment: A systematic review and meta-analysis. *Kidney Research and Clinical Practice*. 2020;39(1):81.
14. Park WY. Controversies in acetaminophen nephrotoxicity. *Kidney Research and Clinical Practice*. 2020;39(1):4.
15. Somani SM, Husain K, Whitworth C, Trammell GL, Malafa M, Rybak LP. Dose-dependent protection by lipoic acid against cisplatin-induced nephrotoxicity in rats: antioxidant defense system. *Pharmacology & Toxicology*. 2000;86(5):234-241.
16. Wang X, Wu Q, Liu A, et al. Paracetamol: overdose-induced oxidative stress toxicity, metabolism, and protective effects of various compounds in vivo and in vitro. *Drug metabolism reviews*. 2017;49(4):395-437.
17. El-Boshy M, BaSalamah MA, Ahmad J, et al. Vitamin D protects against oxidative stress, inflammation and hepatorenal damage induced by acute paracetamol toxicity in rat. *Free Radical Biology and Medicine*. 2019;141:310-321.
18. Ghosh J, Das J, Manna P, Sil PC. Acetaminophen induced renal injury via oxidative stress and TNF- α production: therapeutic potential of arjunolic acid. *Toxicology*. 2010;268(1-2):8-18.
19. Inci H, Izol E, Yilmaz MA, Ilkaya M, Bingöl Z, Gülçin I. Comprehensive phytochemical content by LC/MS/MS and anticholinergic, antiglaucoma, antiepilepsy, and antioxidant activity of apilarnil (Drone Larvae). *Chemistry & Biodiversity*. 2023;20(10):e202300654.
20. Elashal MH, Abd El-Wahed AA, Mohamed MA, et al. Apilarnil ameliorates Bisphenol A-induced testicular toxicity in adult male rats via improving antioxidant potency and PCNA expression. *Reproductive Toxicology*. 2024;125:108570.
21. Doğanyigit Z, Okan A, Kaymak E, Pandır D, Silici S. Investigation of protective effects of apilarnil against lipopolysaccharide induced liver injury in rats via TLR 4/HMGB-1/NF- κ B pathway. *Biomedicine & Pharmacotherapy*. 2020;125:109967.
22. Gokkaya EO, Yesilot S, Ozgocmen M, Aslankoc R, Aydin Acar C. Protective effects of resveratrol and avocado oil against paracetamol-induced hepatotoxicity in rats. *Drug and Chemical Toxicology*. 2022;45(5):2131-2139.
23. Ban KY, Nam GY, Kim D, Oh YS, Jun HS. Prevention of LPS-Induced acute kidney injury in mice by Bavachin and its potential mechanisms. *Antioxidants*. 2022;11(11):2096.

24. Carter JH, Douglass LE, Deddens JA, et al. Pak-1 expression increases with progression of colorectal carcinomas to metastasis. *Clinical Cancer Research*. 2004;10(10):3448-3456.
25. Hamamci M, Doganyigit Z, Silici S, et al. Apilarnil: a novel neuroprotective candidate. *Acta Neurologica Taiwanica*. 2020;29(2):33-45.
26. Stollings JL, Wheeler AP, Rice TW. Incidence and characterization of acute kidney injury after acetaminophen overdose. *Journal of Critical Care*. 2016;35:191-194.
27. Zhang X, Long F, Li R, et al. Tanshinone IIA prevents acetaminophen-induced nephrotoxicity through the activation of the Nrf2-Mrp2/4 pathway in mice. *Environmental Toxicology*. 2022;37(7):1618-1628.
28. Kandemir FM, Kucukler S, Eldutar E, Caglayan C, Gülçin İ. Chrysin protects rat kidney from paracetamol-induced oxidative stress, inflammation, apoptosis, and autophagy: a multi-biomarker approach. *Scientia Pharmaceutica*. 2017;85(1):4.
29. Nouioura G, Kettani T, Tourabi M, et al. The protective potential of *Petroselinum crispum* (Mill.) Fuss. on paracetamol-induced hepato-renal toxicity and antiproteinuric effect: A biochemical, hematological, and histopathological study. *Medicina*. 2023;59(10):1814.
30. Sohn SH, Lee EY, Lee JH, et al. Screening of herbal medicines for recovery of acetaminophen-induced nephrotoxicity. *Environmental Toxicology and Pharmacology*. 2009;27(2):225-230.
31. İlbey YÖ, Ozbek E, Cekmen M, et al. Melatonin prevents acetaminophen-induced nephrotoxicity in rats. *International Urology and Nephrology*. 2009;41:695-702.
32. Canayakin D, Bayir Y, Kilic Baygutalp N, et al. Paracetamol-induced nephrotoxicity and oxidative stress in rats: the protective role of *Nigella sativa*. *Pharmaceutical Biology*. 2016;54(10):2082-2091.
33. Baponwa O, Amang A, Mezui C, et al. Antioxidant mechanism of renal and hepatic failure prevention related to paracetamol overdose by the aqueous extract of *Amblygonocarpus andongensis* stem bark. *BioMed Research International*. 2022;2022(1):1846558.
34. Akgun E, Boyacioglu M, Kum S. The potential protective role of folic acid against acetaminophen-induced hepatotoxicity and nephrotoxicity in rats. *Experimental Animals*. 2021;70(1):54-62.
35. Mohammed SA, Eldeeb HM, Mohammed HA, et al. Roles of *Suaeda vermiculata* aqueous-ethanolic extract, its subsequent fractions, and the isolated compounds

in hepatoprotection against paracetamol-induced toxicity as compared to silymarin. *Oxid Med Cell Longev*. 2021;6174897.2021.

36. Ahmad B, Muhammad Yousafzai A, Maria H, et al. Curative effects of *Dianthus orientalis* against paracetamol triggered oxidative stress, hepatic and renal injuries in rabbit as an experimental model. *Separations*. 2023;10(3):182.
37. Abd El-Wahed AA, Khalifa SA, Aldahmash B, et al. Exploring the chemical constituents and nutritive potential of bee drone (apilarnil): emphasis on antioxidant properties. *Chemistry & Biodiversity*. 2024:e202400085.
38. Doğanyığıt Z, Köklü B, Uner A, Okan A, Kaymak E, Silici S. The effect of apilarnil on the autophagia against lipopolysaccharite-based sepsis in liver. *New Trends in Medicine Sciences*. 2020;1(2):84-89.
39. Ozatik FY, Teksen Y, Kadioglu E, Ozatik O, Bayat Z. Effects of hydrogen sulfide on acetaminophen-induced acute renal toxicity in rats. *International Urology and Nephrology*. 2019;51:745-754.
40. Inandiklioglu N, Doganyigit Z, Okan A, Kaymak E, Silici S. Nephroprotective effect of apilarnil in lipopolysaccharide-induced sepsis through TLR4/NF- κ B signaling pathway. *Life Sciences*. 2021;284:119875.

Integrated MRI-Derived, Pathologic, and Molecular Biomarkers for Prediction of Neoadjuvant Chemotherapy Response in Breast Cancer

Mehmet Ali NAZLI*, Melis BAYKARA ULUSAN**, Fadime Didem TRABULUS***, Rıza Umar GÜRSU****, Emel ESMERER*****, Esra Canan KELTEN TALU*****

Abstract

Aim: To investigate the predictive value of pretreatment breast magnetic resonance imaging (MRI) findings, clinicopathological characteristics, and molecular tumor features for pathological response to neoadjuvant chemotherapy (NACT).

Method: This retrospective study included 194 patients with invasive breast cancer who underwent pretreatment breast MRI, received NACT, and subsequently underwent surgery between 2015 and 2020. Pathological response was assessed using the Miller–Payne grading system and categorized as complete/near-complete response (grades 4–5), partial response (grade 3), or limited response (grades 1–2). Quantitative and morphological MRI parameters, together with clinicopathological and molecular characteristics, were analyzed. Independent predictors of pathological response were identified using multinomial logistic regression analysis.

Results: According to the Miller–Payne classification, 80 patients (41.2%) achieved complete/near-complete response, 98 (50.5%) partial response, and 16 (8.2%) limited response. Histologic subtype, tumor grade, HER2 status, Ki-67 index, molecular subtype, ADC, BPE, tumor margins, enhancement pattern, and MSI were significantly associated with pathological response. In multivariable analysis, non-ductal histology and minimal BPE independently predicted limited versus complete/near-complete response, whereas non-luminal molecular subtype, minimal BPE, and MSI ≥ 429 independently predicted limited versus partial response. Lower ADC independently distinguished partial from complete/near-complete response. However, substantial overlap in biological and imaging features remained across response groups.

Conclusion: Pretreatment MRI biomarkers may provide complementary information for predicting NACT response when interpreted with clinicopathologic and molecular features. Lower ADC was not an independent predictor of limited response. The occurrence of similar biological and imaging features in both

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 21.06.2026 Kabul / Accepted: 19.08.2026

DOI: <https://doi.org/10.38079/igusabder.1975607>

* (Corresponding Author) MD, Department of Radiology, Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye.

E-mail: mnazli46@yahoo.com ORCID <https://orcid.org/0000-0003-4605-7822>

** MD., Department of Radiology, Istanbul Training and Research Hospital, Istanbul, Türkiye.

E-mail: melisbulusan@gmail.com ORCID <https://orcid.org/0000-0002-4728-1802>

*** Assoc. Prof. Dr., Department of General Surgery, Göztepe Medical Park Hospital, Istanbul, Türkiye.

E-mail: didemcan73@gmail.com ORCID <https://orcid.org/0000-0003-1687-715X>

**** MD., Department of Medical Oncology, Istanbul Training and Research Hospital, Istanbul, Türkiye.

E-mail: rumar80@yahoo.com ORCID <https://orcid.org/0000-0002-6331-3632>

***** MD., Department of Radiology, Başakşehir Çam and Sakura City Hospital, Istanbul, Türkiye.

E-mail: emelure@gmail.com ORCID <https://orcid.org/0000-0002-8273-976X>

***** Prof. Dr., Department of Pathology, Izmir Tepecik Training and Research Hospital, Izmir, Türkiye.

E-mail: ecanankelten@gmail.com ORCID <https://orcid.org/0000-0001-8767-4275>

ETHICAL STATEMENT: The study was approved by the Clinical Research Ethics Committee of Istanbul Training and Research Hospital (Decision No: 3, Approval Date: January 14, 2022). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

highly responsive and limited-response tumors highlights substantial treatment-response heterogeneity and supports an integrated multiparametric assessment rather than reliance on any single biomarker.

Keywords: Breast cancer, neoadjuvant chemotherapy, breast MRI, imaging biomarkers, pathological treatment response.

Meme Kanserinde Neoadjuvan Kemoterapi Yanıtının Öngörülmesinde MRG Tabanlı, Patolojik ve Moleküler Biyobelirteçler

Öz

Amaç: Bu çalışmanın amacı, meme kanserli hastalarda neoadjuvan kemoterapiye (NAKT) patolojik yanıtın öngörülmesinde tedavi öncesi meme manyetik rezonans görüntüleme (MRG) bulguları ile klinikopatolojik ve moleküler tümör özelliklerinin prediktif değerini araştırmaktır.

Yöntem: Bu retrospektif çalışmaya, 2015–2020 yılları arasında tedavi öncesi meme MRG incelemesi yapılan, NAKT uygulanan ve ardından cerrahi tedavi gerçekleştirilen 194 invaziv meme kanseri hastası dahil edildi. Patolojik yanıt Miller–Payne derecelendirme sistemine göre değerlendirildi ve tam/tama yakın yanıt (derece 4–5), parsiyel yanıt (derece 3) ve sınırlı yanıt (derece 1–2) olarak sınıflandırıldı. Kantitatif ve morfolojik MRG parametreleri ile klinikopatolojik ve moleküler özellikler analiz edildi. Patolojik yanıtın bağımsız belirleyicileri multinomiyal lojistik regresyon analizi ile değerlendirildi.

Bulgular: Miller–Payne sınıflamasına göre hastaların 80'i (%41,2) tam/tama yakın, 98'i (%50,5) parsiyel ve 16'sı (%8,2) sınırlı yanıt gösterdi. Histolojik alt tip, tümör derecesi, HER2 durumu, Ki-67 indeksi, moleküler alt tip, ADC, BPE, tümör kenar özellikleri, kontrastlanma paterni ve MSI patolojik yanıt ile anlamlı ilişkiliydi. Çok değişkenli analizde non-duktal histoloji ve minimal BPE, tam/tama yakın yanıtla göre sınırlı yanıt; non-luminal moleküler alt tip, minimal BPE ve MSI ≥ 429 ise parsiyel yanıtla göre sınırlı yanıtı bağımsız olarak öngördü. Düşük ADC değerleri parsiyel yanıtı tam/tama yakın yanıttan bağımsız olarak ayırt etti. Bununla birlikte, yanıt grupları arasında biyolojik ve görüntüleme özellikleri açısından belirgin örtüşme gözlemlendi.

Sonuç: Tedavi öncesi MRG biyobelirteçleri, klinikopatolojik ve moleküler özelliklerle birlikte değerlendirildiğinde NAKT yanıtının öngörülmesine tamamlayıcı bilgi sağlayabilir. Düşük ADC sınırlı yanıtın bağımsız belirleyicisi değildir. Aynı biyolojik ve görüntüleme özelliklerinin hem yüksek hem de sınırlı yanıt gösteren tümörlerde bulunabilmesi, tedavi yanıtındaki belirgin heterojenliği ortaya koymakta ve tek bir belirteç yerine bütünlük, multiparametrik değerlendirmeyi desteklemektedir.

Anahtar Sözcükler: Meme kanseri, neoadjuvan kemoterapi, meme MRG, görüntüleme biyobelirteçleri, patolojik tedavi yanıtı.

Introduction

Neoadjuvant chemotherapy (NACT) has become an integral component of modern breast cancer management, particularly for patients with HER2-positive and triple-negative breast cancer. In addition to increasing the feasibility of breast-conserving surgery, NACT facilitates axillary de-escalation strategies and offers a unique opportunity to evaluate tumor sensitivity to systemic therapy through post-treatment pathologic assessment. Achieving a pathologic complete response (pCR) is consistently associated with favorable long-term outcomes, whereas residual disease is linked to an increased risk of recurrence and poorer survival^{1,2}. However, residual disease represents a biologically heterogeneous entity, and prognosis varies according to the extent of

residual tumor burden and intrinsic tumor characteristics^{3,4}. Consequently, identifying pretreatment factors predictive of treatment response remains an important clinical objective.

Treatment response to NACT is determined by a complex interplay of clinicopathologic and molecular characteristics, including histologic subtype, tumor grade, hormone receptor status, HER2 expression, Ki-67 proliferation index, and molecular subtype^{3,4}. Breast magnetic resonance imaging (MRI) provides complementary information by characterizing both tumor morphology and functional features of the tumor microenvironment. Conventional morphologic findings, apparent diffusion coefficient (ADC) values, and dynamic contrast-enhanced MRI parameters have all been investigated as potential imaging biomarkers for predicting treatment response^{5,6}.

More recently, radiomics and deep learning-based models have demonstrated promising predictive performance. Nevertheless, their routine clinical implementation remains limited because of concerns regarding interpretability, reproducibility, external validation, and real-world applicability⁷⁻¹⁰. In contrast, MRI-derived imaging biomarkers, together with routinely available pathologic and molecular characteristics, can be readily incorporated into multidisciplinary decision-making without requiring additional software, complex post-processing, or specialized imaging protocols.

We investigated the predictive value of pretreatment MRI-derived imaging biomarkers, together with clinicopathologic and molecular characteristics, for pathologic response following NACT in patients with breast cancer.

Material and Methods

Patient Selection and Inclusion Criteria

A retrospective review of our institutional database was conducted to screen individuals with histologically validated invasive breast carcinoma who were managed via a multidisciplinary approach and received NACT between January 2015 and December 2020. Eligibility criteria required the completion of neoadjuvant therapy at our center, the availability of baseline breast MRI scans, subsequent definitive surgical intervention, and accessible histopathologic evaluation of surgical specimens to determine treatment response. Patients were excluded if clinical data were incomplete, pretreatment breast MRI was unavailable, surgery had been performed outside our institution, or pre- or post-treatment pathologic records were missing. After these exclusions, 194 patients remained for the final analysis.

Clinicopathologic Variables

Clinical and histopathologic data were retrieved from the hospital information system (HIS). Variables of interest included histologic subtype, tumor grade, ER status, PR status, HER2 status, Ki-67 proliferation index, and molecular subtype. According to immunohistochemical findings, tumors were categorized as luminal A, luminal

B/HER2-negative, luminal B/HER2-positive, HER2-enriched, or triple-negative breast cancer.

MRI Acquisition and Analysis

All patients underwent pretreatment breast MRI on a 1.5-T SIGNA Explorer system (GE Healthcare, Milwaukee, WI, USA) using a dedicated bilateral breast coil. The protocol included T2-weighted imaging, diffusion-weighted imaging with b values of 0 and 800 s/mm², and three-dimensional fat-suppressed T1-weighted dynamic contrast-enhanced MRI. ADC maps were automatically generated from images acquired at both b values. A gadolinium-based contrast agent (0.1 mmol/kg) was administered at 2 mL/s, followed by a 20-mL saline flush. Five postcontrast phases were acquired at 60-second intervals.

MRI examinations were retrospectively reviewed for morphologic and quantitative imaging biomarkers. Morphologic variables included lesion morphology, tumor margins, background parenchymal enhancement (BPE), enhancement distribution pattern, ipsilateral breast vascularity, and axillary nodal involvement.

Quantitative parameters included the ADC, time to peak enhancement (TTP), maximum signal increase (MSI), and baseline MRI tumor size. ADC was measured using manually placed circular regions of interest (30–50 mm²) positioned over the lowest-ADC region within the solid tumor while avoiding necrotic, cystic, and hemorrhagic areas. The lowest value (ADC_{min}) was used for analysis.

Dynamic contrast-enhanced (DCE) MRI analyses were performed on a GE Advantage Workstation using the manufacturer's standard software. MSI represented the maximum percentage increase in signal intensity relative to baseline, whereas TTP represented the interval between contrast administration and peak enhancement.

Pathologic Response Assessment

Following completion of NACT, patients underwent definitive breast surgery. Surgical specimens were evaluated by dedicated breast pathologists, and treatment response was graded according to the Miller–Payne grading system. Responses were categorized as complete/near-complete (grades 4–5), partial (grade 3), or limited (grades 1–2). In the present study, Miller–Payne grades 1–2 were classified as limited response, reflecting only minimal reduction in tumor cellularity following NACT. This response classification served as the primary study outcome.

Ethical Statement

The study protocol was approved by the Clinical Research Ethics Committee of Istanbul Training and Research Hospital, Türkiye (Decision No: 3, Date: January 14, 2022).

Statistical Analysis

Continuous variables were assessed for normality and summarized as mean $\pm$ standard deviation (SD). Comparisons among the three response groups were performed using one-way analysis of variance (ANOVA) for normally distributed variables and the Kruskal–Wallis test for non-normally distributed variables, whereas categorical variables were analyzed using the chi-square test. ROC curve analysis was used to determine optimal cutoff values for quantitative MRI biomarkers. Variables showing significant associations in univariable analyses were entered into a multinomial logistic regression model to identify independent predictors of treatment response. Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs). All tests were two-sided, and $p < 0.05$ was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA).

Results

Patient Characteristics and Pathologic Response

The final cohort included 194 patients. Of these, 80 (41.2%) achieved a complete or near-complete pathologic response, 98 (50.5%) had a partial response, and 16 (8.2%) demonstrated limited response after NACT. Age, family history of breast cancer, lymphovascular invasion, tumor necrosis, progesterone receptor status, and baseline tumor size were comparable across the three response groups (all $p > 0.05$). Conversely, histologic subtype, tumor grade, HER2 expression, Ki-67 proliferation index, and molecular subtype differed significantly according to treatment response (Table 1).

Invasive ductal histology and HER2-positive tumors were observed more frequently in patients who achieved a complete or near-complete response, whereas both features were less common in patients with partial or limited response. Tumor grade also differed significantly among the three response categories. Molecular subtype distribution varied significantly ($p < 0.001$), with HER2-positive molecular subtypes overrepresented among complete or near-complete responders, whereas triple-negative tumors accounted for more than half of the limited-response group (56.3%). When classified according to biologic phenotype, non-luminal tumors were significantly more common in patients with limited response than in those with complete or near-complete or partial response (62.5%, 33.8%, and 26.5%, respectively; $p = 0.016$).

Table 1. Clinicopathologic characteristics according to pathologic response category. complete/near-complete response, Miller–Payne grades 4–5; partial response, Miller–Payne grade 3; limited response, Miller–Payne grades 1–2.

Characteristic	Complete/ Near-complete (n=80)	Partial (n=98)	Limited (n=16)	p
Invasive ductal carcinoma, n (%)	69 (86.3)	71 (72.4)	9 (56.3)	0.012
Grade III, n (%)	45 (60.0)	35 (36.1)	11 (68.8)	0.002
HER2-positive, n (%)	37 (46.3)	21 (21.4)	4 (25.0)	0.002
Ki-67 $\geq 35\%$, n (%)	56 (70.9)	51 (52.0)	14 (87.5)	0.004
Non-luminal molecular subtype, n (%)	27 (33.8)	26 (26.5)	10 (62.5)	0.016

Abbreviations: *HER2*, human epidermal growth factor receptor 2; *TNBC*, triple-negative breast cancer.

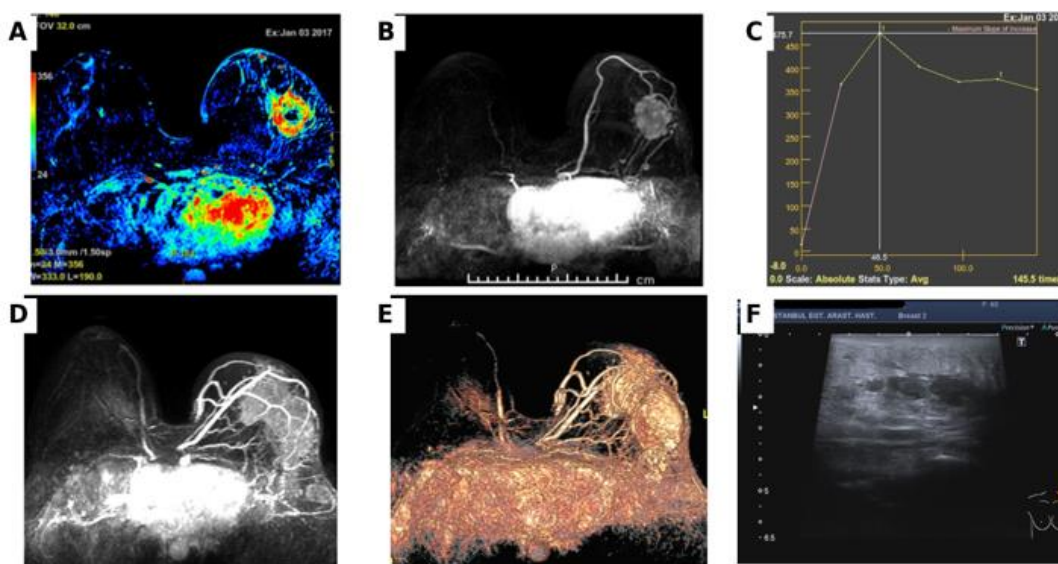
Note: Non-luminal molecular subtype comprised *HER2*-enriched and *TNBC* tumors. *HER2*-positive refers to *HER2* receptor status. Percentages were calculated using available data.

MRI Findings and Quantitative Imaging Biomarkers

Overall lesion morphology, lesion location, enhancement symmetry, time-to-peak enhancement, kinetic curve type, baseline tumor size, and extensive nodal involvement were not associated with treatment response (all $p > 0.05$).

Among qualitative MRI features, circumscribed or lobulated margins were more frequent in patients with limited response than in complete/near-complete or partial responders (62.5% vs. 27.5% and 32.7%, $p = 0.025$). Minimal BPE was also more common in patients with limited response (37.5% vs. 11.3% and 10.2%, $p = 0.009$).

Quantitative MRI biomarkers also differed across response groups. Mean ADC values were highest in complete/near-complete responders ($0.92 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$), intermediate in partial responders ($0.87 \pm 0.13 \times 10^{-3} \text{ mm}^2/\text{s}$), and lowest in patients with limited response ($0.79 \pm 0.24 \times 10^{-3} \text{ mm}^2/\text{s}$; $p = 0.002$). ADC values $> 0.93 \times 10^{-3} \text{ mm}^2/\text{s}$ were more common among complete/near-complete responders than among partial or limited responders (47.5% vs. 29.6% and 31.3%, $p = 0.043$). Peripheral enhancement was observed more frequently in patients with limited response (53.3% vs. 30.0% and 22.7%, $p = 0.043$). MSI was highest in patients with limited response (405.6 ± 212.9), followed by complete/near-complete (303.9 ± 166.1) and partial responders (288.4 ± 130.5 ; $p = 0.017$), whereas $\text{MSI} \geq 429$ was associated with limited response ($p = 0.040$).

Figure 1. Representative case of poor response to NACT.

A 40-year-old woman with cT2N1 grade 3 TNBC of the left breast. Pretreatment MRI demonstrates marked enhancement on the maximum signal increase map (A), an enhancing breast mass on MIP (B), and rapid early enhancement on kinetic analysis (C). Despite NACT, follow-up MRI (D, E) and US (F) demonstrate marked local tumor progression with associated breast edema and axillary lymphadenopathy, consistent with progressive disease, which was confirmed by surgical pathology.

Abbreviations: TNBC, triple-negative breast cancer; NACT, neoadjuvant chemotherapy; MSI, maximum signal increase; MIP, maximum-intensity projection imaging; US, ultrasonography.

Table 2. MRI Findings and Quantitative Imaging Biomarkers.

Variable	Complete/ Near-complete	Partial	Limited Response	p
Circumscribed or lobulated margin, n (%)	22 (27.5)	32 (32.7)	10 (62.5)	0.025
Minimal BPE, n (%)	9 (11.3)	10 (10.2)	6 (37.5)	0.009
ADC, mean $\pm$ SD ($\times 10^{-3}$ mm ² /s)	0.92 $\pm$ 0.16	0.87 $\pm$ 0.13	0.79 $\pm$ 0.24	0.002
ADC >0.93 $\times 10^{-3}$ mm ² /s, n (%)	38 (47.5)	29 (29.6)	5 (31.3)	0.043
Peripheral enhancement, n (%)	24 (30.0)	22 (22.7)	8 (53.3)	0.043
MSI, mean $\pm$ SD	303.9 $\pm$ 166.1	288.4 $\pm$ 130.5	405.6 $\pm$ 212.9	0.017
MSI $\geq$ 429, n (%)	16 (20.0)	16 (16.3)	7 (43.8)	0.040

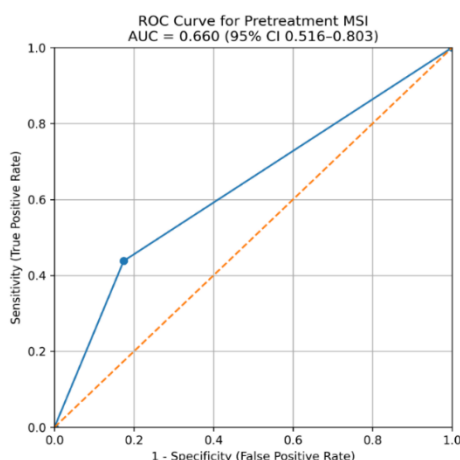
Abbreviations: ADC, apparent diffusion coefficient; BPE, background parenchymal enhancement; MSI, maximum signal increase. Percentages were calculated using available data.

ROC Analysis

ROC analysis demonstrated that pretreatment ADC values were significantly associated with complete/near-complete pathologic response. The AUC for ADC was 0.613 (95% CI: 0.532–0.693; $p = 0.008$). The optimal cutoff value was $0.93 \times 10^{-3} \text{ mm}^2/\text{s}$, yielding a sensitivity of 47.5% and a specificity of 70.2% for identifying complete/near-complete response.

For prediction of limited response, MSI also demonstrated significant discriminatory performance. The AUC was 0.660 (95% CI: 0.516–0.803; $p=0.034$). The optimal MSI cutoff value was 429, corresponding to a sensitivity of 43.8% and a specificity of 82.6%.

Figure 2. ROC curve of pretreatment MSI for prediction of limited response following NACT.



The AUC was 0.660 (95% CI: 0.516–0.803; $p=0.034$). The optimal cutoff value was 429, corresponding to a sensitivity of 43.8% and specificity of 82.6%.

Abbreviations: ROC, receiver operating characteristic; MSI, maximum signal increase; AUC, area under the curve; CI, confidence interval.

Multivariable Analysis

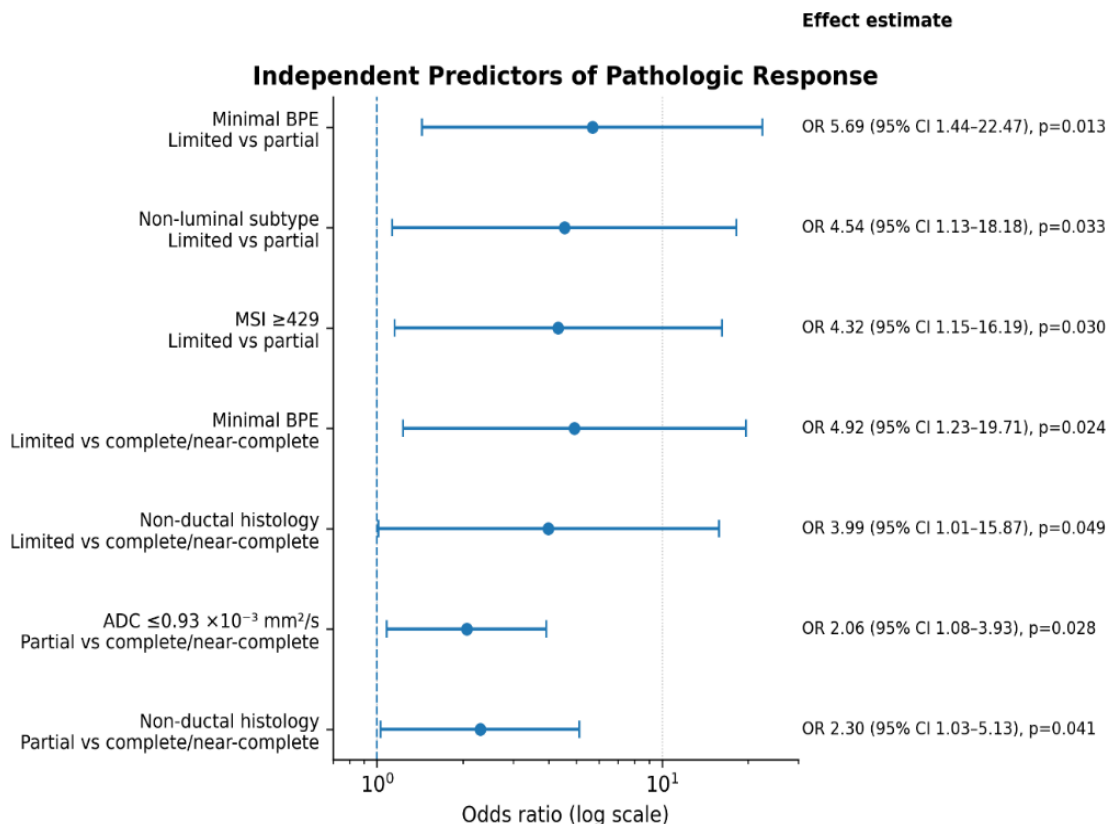
Using complete/near-complete response as the reference category, non-ductal histology (OR=2.30, 95% CI: 1.03–5.13; $p=0.041$) and low ADC values ($\leq 0.93 \times 10^{-3} \text{ mm}^2/\text{s}$; OR=2.06, 95% CI: 1.08–3.93; $p=0.028$) independently predicted partial response. When limited response was compared with complete/near-complete response, non-ductal histology (OR=3.99, 95% CI: 1.01–15.87; $p=0.049$) and minimal background parenchymal enhancement (BPE) (OR=4.92, 95% CI: 1.23–19.71; $p=0.024$) independently predicted limited response. Finally, with partial response as the reference category, non-luminal molecular subtype (OR=4.54, 95% CI: 1.13–18.18; $p=0.033$), minimal BPE (OR=5.69, 95% CI: 1.44–22.47; $p=0.013$), and $\text{MSI} \geq 429$ (OR=4.32, 95% CI: 1.15–16.19; $p=0.030$) independently predicted limited response.

Overall, biological tumor characteristics and MRI-derived biomarkers provided complementary information for treatment-response stratification. The multinomial logistic regression results are presented in Table 3 and graphically summarized in Figure 3.

Table 3. Independent predictors of pathologic response identified by multinomial logistic regression.

Comparison / Predictor	OR (95% CI)	P
<u>Partial vs Complete/near-complete</u>		
Non-ductal histology	2.30 (1.03–5.13)	0.041
ADC $\leq 0.93 \times 10^{-3} \text{ mm}^2/\text{s}$	2.06 (1.08–3.93)	0.028
<u>Limited vs Complete/near-complete</u>		
Non-ductal histology	3.99 (1.01–15.87)	0.049
Minimal BPE	4.92 (1.23–19.71)	0.024
<u>Limited vs Partial</u>		
Non-luminal subtype	4.54 (1.13–18.18)	0.033
Minimal BPE	5.69 (1.44–22.47)	0.013
MSI ≥ 429	4.32 (1.15–16.19)	0.030

Abbreviations: OR, odds ratio; CI, confidence interval; ADC, apparent diffusion coefficient; BPE, background parenchymal enhancement; MSI, maximum signal increase.

Figure 3. Independent predictors of pathologic response after neoadjuvant chemotherapy.

Forest plot showing ORs and 95% CIs derived from multinomial logistic regression analysis. Limited response corresponds to Miller–Payne grades 1–2, representing tumors with minimal reduction in tumor cellularity following NACT.

Abbreviations: OR, odds ratio; CI, confidence interval; ADC, apparent diffusion coefficient; BPE, background parenchymal enhancement; MSI, maximum signal increase.

Discussion

NACT is a cornerstone of treatment for biologically aggressive breast cancer because it facilitates surgical downstaging while providing an *in vivo* assessment of treatment sensitivity. Although established clinicopathologic factors remain the principal determinants of response, accurate pretreatment identification of patients at risk for poor response continues to represent an important clinical challenge. In the present cohort, histologic subtype, tumor grade, HER2 status, Ki-67 proliferation index, and molecular subtype were strongly associated with pathologic response, confirming the central role of intrinsic tumor biology. Importantly, MRI-derived biomarkers, particularly ADC, BPE, and MSI, provided complementary information beyond these

established factors, suggesting that treatment response reflects both intrinsic tumor biology and imaging-visible characteristics of the tumor microenvironment^{4-6,11}.

Despite these established biologic determinants, substantial variability persisted within individual molecular subgroups, indicating that biologic classification alone does not fully explain treatment sensitivity^{4,12-14}. Patients with apparently similar clinicopathologic profiles frequently exhibited markedly different treatment outcomes, suggesting that MRI-derived biomarkers reflecting the tumor microenvironment provide complementary information for pretreatment response prediction. Consistent with this observation, patients with limited response in our cohort represented a biologically distinct subgroup characterized not only by adverse clinicopathologic features but also by distinctive MRI findings.

Luminal tumors exhibited lower rates of complete or near-complete response than HER2-positive tumors, consistent with their lower chemosensitivity. However, they rarely demonstrated marked treatment resistance, indicating that failure to achieve pCR should not automatically be interpreted as treatment failure in hormone receptor-positive disease. Conversely, despite generally favorable response rates to NACT, TNBC accounted for more than half of the limited-response tumors in our cohort, underscoring the biologic heterogeneity of this subtype. Previous molecular classifications similarly demonstrated substantial variation in chemosensitivity across TNBC subtypes. Lehmann et al. reported the highest pCR rates in basal-like 1 tumors, whereas luminal androgen receptor and mesenchymal subtypes more frequently exhibited residual disease. Similarly, Bianchini et al. emphasized the clinical heterogeneity of TNBC and its implications for treatment response. This heterogeneity was also reflected in our imaging findings, in which minimal BPE, lower ADC values, and elevated MSI were more common among patients with limited response^{4,12-14}.

ADC showed a graded association with treatment response, with the highest mean values observed in complete/near-complete responders and the lowest values in patients with limited response. However, dichotomized low ADC independently distinguished partial from complete/near-complete response but did not remain an independent predictor in comparisons involving limited response. These findings suggest that ADC reflects tumor cellularity and treatment sensitivity but may have limited specificity as an isolated marker of treatment resistance. Its interpretation may also be influenced by underlying histopathologic heterogeneity, particularly in tumors with mixed or metaplastic components^{15,16}.

Among the imaging biomarkers evaluated, BPE was one of the strongest predictors of limited response. Increasing evidence suggests that BPE reflects not only hormonal status but also characteristics of the breast microenvironment¹⁷⁻¹⁹. A recent systematic review by Li and Yan summarized the growing evidence linking BPE to response following NACT, although study findings remain heterogeneous¹⁷. Similarly, Preibsch et al. demonstrated that changes in BPE during treatment correlate with response, whereas Onishi et al. reported poorer outcomes in patients without BPE suppression^{18,19}. Consistent with these observations, pretreatment minimal BPE remained an

independent predictor of limited response in our cohort. These findings suggest that minimal BPE is not a deterministic marker of treatment resistance but rather a clinically relevant pretreatment imaging biomarker that identifies patients at increased risk of limited response.

DCE MRI parameters provided additional information regarding treatment sensitivity. MSI remained independently associated with limited rather than partial response after adjustment for clinicopathologic and molecular variables. As a measure of enhancement intensity, elevated MSI may reflect increased angiogenic activity, vascular permeability, and tumor perfusion. Together, ADC and MSI provide complementary information on the cellular and vascular components of tumor biology. Considerable overlap between response groups remained despite the associations observed. Although non-luminal molecular subtypes and non-ductal histology were more common among patients with limited response, many patients with these characteristics still achieved favorable treatment outcomes, underscoring the biologic heterogeneity within molecular classification of breast cancer^{4,12-14}. Rather than serving as deterministic markers of treatment resistance, these clinicopathologic and imaging features should be viewed as risk indicators that identify patients more likely to exhibit limited response and who may benefit from closer monitoring during NACT.

Morphologic MRI features also differed according to treatment response. Circumscribed or lobulated margins and peripheral enhancement are frequently encountered in TNBCs with favorable responses to neoadjuvant chemotherapy; however, similar features were also observed in a subset of non-luminal tumors with limited response. These findings indicate that MRI morphology reflects underlying tumor biology rather than treatment sensitivity alone. Although morphologic features were not independent predictors in multivariable analysis, they may provide valuable complementary information when interpreted alongside quantitative MRI biomarkers and molecular characteristics and could therefore contribute to a multiparametric prediction model. Consistent with our findings, Goorts et al. demonstrated that MRI response patterns correlate with pathologic outcome following NACT, supporting the complementary role of imaging in treatment response assessment²⁰.

The observation that relatively well-defined tumor margins were also encountered among some tumors with limited response may initially appear counterintuitive. However, certain histologic subtypes, particularly metaplastic breast carcinomas, are known to exhibit deceptively circumscribed or lobulated imaging appearances despite their aggressive biologic behavior. McCart Reed et al. highlighted the molecular and prognostic aggressiveness of metaplastic breast cancer, while Yoon et al. described its tendency to present with relatively circumscribed imaging morphology^{15,16}. Therefore, morphologic MRI findings should not be interpreted as direct indicators of treatment resistance but rather as imaging manifestations of the biologic heterogeneity that exists across breast cancer subtypes.

A major strength of the present study is its clinical applicability. All imaging biomarkers evaluated—including tumor morphology, ADC, BPE, and MSI—were derived from

routine breast MRI examinations using standard vendor-provided post-processing tools and did not require dedicated radiomics platforms or additional specialized software. Likewise, the accompanying biologic variables are already available from standard pathologic assessment. Because breast MRI is an established component of neoadjuvant treatment planning, integrating these routinely available imaging and biologic data into response prediction could be implemented without altering current clinical workflows^{2,5,17}.

Although patients with limited response represented only a small proportion of the cohort (8.2%), their clinical importance is disproportionately high. Previous studies have demonstrated that residual disease following NACT is associated with substantially different long-term outcomes according to residual disease burden and breast cancer subtype^{4,14}. Failure to recognize poorly responding tumors before or early during neoadjuvant treatment may result in ineffective treatment exposure, delays in definitive local therapy, and missed opportunities for timely treatment modification.¹¹ Therefore, the ability to identify patients at increased risk for limited response before treatment initiation may have important clinical implications. Importantly, the imaging and biologic features identified in our study should not be interpreted as deterministic markers of treatment resistance. Rather, they may help define a subgroup in which treatment-resistant disease is encountered more frequently, consistent with the well-recognized heterogeneity of treatment response observed within individual breast cancer subtypes^{4,14}.

This study has several limitations. First, its retrospective single-center design may have introduced selection bias. Second, the limited-response group was small ($n = 16$), reducing statistical power and resulting in wide 95% confidence intervals for several multivariable estimates; these findings should therefore be interpreted cautiously. Third, MSI measurements were derived using vendor-specific post-processing software, which may limit the generalizability of the proposed threshold across different MRI platforms. Fourth, although several MRI-derived biomarkers emerged as independent predictors of treatment response, the study was not designed to develop or externally validate a predictive model. In addition, residual cancer burden (RCB) was not routinely assessed during the study period; therefore, treatment response was evaluated using the Miller–Payne grading system. External validation in independent cohorts will be necessary to confirm the reproducibility and generalizability of these findings.

Conclusion

Pretreatment breast MRI findings may provide complementary information for predicting response to NACT when interpreted together with clinicopathologic and molecular features. Non-ductal histology, non-luminal molecular subtype, minimal BPE, and elevated MSI were associated with limited response, whereas lower ADC independently distinguished partial from complete/near-complete response but was not an independent predictor of limited response. Importantly, similar biological and imaging features were observed in both highly responsive and limited-response tumors, highlighting substantial treatment-response heterogeneity within the same phenotypic

profiles. These findings suggest that such biomarkers should not be interpreted as isolated markers of resistance, but rather as complementary indicators supporting integrated pretreatment risk stratification.

REFERENCES

1. Cortazar P, Zhang L, Untch M, et al. Pathological complete response and long-term clinical benefit in breast cancer: the CTNeoBC pooled analysis. *Lancet*. 2014;384(9938):164–172. doi: 10.1016/S0140-6736(13)62422-8
2. Spring LM, Fell G, Arfe A, et al. Pathologic complete response after neoadjuvant chemotherapy and impact on breast cancer recurrence and survival: a comprehensive meta-analysis. *Clin Cancer Res*. 2020;26(12):2838-2848. doi: 10.1158/1078-0432.CCR-19-3492.
3. Loibl S, Poortmans P, Morrow M, Denkert C, Curigliano G. Breast cancer. *Lancet*. 2021;397(10286):1750-1769. doi: 10.1016/S0140-6736(20)32381-3.
4. Symmans WF, Wei C, Gould R, et al. Long-term prognostic risk after neoadjuvant chemotherapy associated with residual cancer burden and breast cancer subtype. *J Clin Oncol*. 2017;35(10):1049-1060. doi: 10.1200/JCO.2015.63.1010.
5. Marinovich ML, Houssami N, Macaskill P, et al. Meta-analysis of magnetic resonance imaging in detecting residual breast cancer after neoadjuvant therapy. *J Natl Cancer Inst*. 2013;105(5):321-333. doi: 10.1093/jnci/djs528.
6. Partridge SC, Nissan N, Rahbar H, Kitsch AE, Sigmund EE. Diffusion-weighted breast MRI: clinical applications and emerging techniques. *J Magn Reson Imaging*. 2017;45(2):337–355. doi: 10.1002/jmri.25479.
7. Grimm LJ. Radiomics: a primer for breast radiologists. *J Breast Imaging*. 2021;3(3):276–287.
8. Lambin P, Leijenaar RTH, Deist TM, et al. Radiomics: the bridge between medical imaging and personalized medicine. *Nat Rev Clin Oncol*. 2017;14(12):749-762.
9. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJWL. Artificial intelligence in radiology. *Nat Rev Cancer*. 2018;18(8):500-510. doi: 10.1038/s41568-018-0016-5.
10. Bluemke DA, Moy L, Bredella MA, et al. Assessing radiology research on artificial intelligence: a brief guide for authors, reviewers, and readers. *Radiology*. 2020;294(3):487-489.

11. Caudle AS, Yu TK, Tucker SL, et al. Local-regional control according to surrogate markers of breast cancer subtypes and response to neoadjuvant chemotherapy in breast cancer patients undergoing breast-conserving therapy. *Breast Cancer Res.* 2012;14(3):R83.
12. Lehmann BD, Bauer JA, Chen X, et al. Identification of human triple-negative breast cancer subtypes and preclinical models for selection of targeted therapies. *J Clin Invest.* 2011;121(7):2750-2767. doi: 10.1172/JCI45014.
13. Bianchini G, Balko JM, Mayer IA, Sanders ME, Gianni L. Triple-negative breast cancer: challenges and opportunities of a heterogeneous disease. *Nat Rev Clin Oncol.* 2016;13(11):674-690. doi: 10.1038/nrclinonc.2016.66.
14. Yau C, Osdoit M, van der Noordaa M, et al. Residual cancer burden after neoadjuvant chemotherapy and long-term survival outcomes in breast cancer: a multicentre pooled analysis of 5161 patients. *Lancet Oncol.* 2022;23(1):149-160. doi: 10.1016/S1470-2045(21)00589-1.
15. McCart Reed AE, Kalaw E, Nones K, et al. Phenotypic and molecular dissection of metaplastic breast cancer and the prognostic implications. *J Pathol.* 2019;247(2):214–227.
16. Yoon GY, Cha JH, Kim HH, et al. Clinicopathological and imaging features predictive of clinical outcome in metaplastic breast cancer. *Curr Med Imaging.* 2020;16(6):729–738.
17. Li X, Yan F. Predictive value of background parenchymal enhancement on breast magnetic resonance imaging for pathological tumor response to neoadjuvant chemotherapy in breast cancers: a systematic review. *Cancer Imaging.* 2024;24(1):35.
18. Preibsch H, Wanner L, Bahrs SD, et al. Background parenchymal enhancement in breast MRI before and after neoadjuvant chemotherapy: correlation with tumour response. *Eur Radiol.* 2016;26(6):1590-1596. doi: 10.1007/s00330-015-4011-x.
19. Onishi N, Li W, Newitt DC, et al. Breast MRI during neoadjuvant chemotherapy: lack of background parenchymal enhancement suppression and inferior treatment response. *Radiology.* 2021;301(2):295-308. doi: 10.1148/radiol.2021203645.
20. Goorts B, Dreuning KMA, Houwers JB, et al. MRI-based response patterns during neoadjuvant chemotherapy can predict pathological complete response in patients with breast cancer. *Breast Cancer Res.* 2018;20(1):34. doi: 10.1186/s13058-018-0950-x.

Effect of miR-105-5p on Cell Proliferation, Colony Formation, and *hTERT*/*P53*/*P21* Gene Expression in Multiple Cancer Cell Lines*

Aylin ÖRS**, Hamide DOĞAN***, Eylem NAS****, Aycan SEZAN*****, Mehmet Yağız ÇAPANOĞLU*****, Taoufik ALLABABİDİ*****, Burcu SAYGIDEĞER*****, Yasemin SAYGIDEĞER*****

Abstract

Aim: MicroRNAs are small endogenous RNA molecules that do not code for proteins but have the capacity to influence cancer development by promoting or inhibiting it. They play normal biological roles in regulating cell metabolism, development, apoptosis, and metastasis. While numerous studies on the functional mechanisms of miRNAs exist, there is limited research in the literature on miR-105-5p, a member of the miR-105 family. This study investigated the effects of miR-105-5p on cell proliferation, colony formation, and the expression of *hTERT*, *P21*, and *P53* genes in five cancer cell lines: A549 (lung), Huh7 (liver), HCT116 (colon), MCF-7 (breast), and HeLa (cervix).

Method: The expression of miR-105-5p was both upregulated and downregulated through transfection in the selected cancer cell lines. After transfection, assays were performed to assess cell proliferation, colony-forming ability, and the expression of the *hTERT*, *P21*, and *P53* genes.

Results: Overexpression of miR-105-5p inhibited proliferation in all cancer cell lines. miR-105-5p suppressed colony formation in A549, MCF-7, HeLa, and Huh7 cells. Differences in the expression levels of *hTERT*, *P53*, and *P21* genes were observed in different cell lines due to the effect of the miR-105-5p mimic.

Conclusion: Direct or indirect differences in *hTERT* gene expression levels suggest that miR-105-5p may be useful in targeted therapy.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 08.09.2025 Kabul / Accepted: 17.08.2026

DOI: <https://doi.org/10.38079/igusabder.1778724>

* This study has been derived from the master's theses "Investigation of the effect of miR-105-5p in hepatocellular carcinoma and colon cancer cells" and "Comparison of the effect of miR-105-5p on apoptosis and stem cell-related genes on A549, MCF7 and hela cell lines", which was accepted in 2022 at Çukurova University, Institute of Science, Department of Biotechnology, Department of Biotechnology and prepared by Eylem NAS under the consultancy of Asst. Prof. Yasemin SAYGIDEĞER ; This study was supported by the Scientific Research Unit of Çukurova University. Project numbers: FYL-2021-14344 and BAP: TYL-2021-13415.

** Department of Biotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.

E-mail: aylinorso1@gmail.com ORCID <https://orcid.org/0000-0001-6137-2439>

*** Dr., Department of Translational Medicine, Institute of Health Sciences, Çukurova University, Adana, Türkiye.

E-mail: hamidebali87@gmail.com ORCID <https://orcid.org/0000-0002-6002-6013>

**** Department of Biotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.

E-mail: eylemn17@gmail.com ORCID <https://orcid.org/0000-0003-3799-9172>

***** Dr., Department of Biotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.

E-mail: aycansezan@gmail.com ORCID <https://orcid.org/0000-0003-1506-7083>

***** Department of Biotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.

E-mail: yagizcpngl@gmail.com ORCID <https://orcid.org/0009-0006-4709-3293>

***** Dr., Department of Biotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.

E-mail: toufic_l@hotmail.com ORCID <https://orcid.org/0009-0000-4936-361X>

***** Dr., Department of Pharmacy Services, Vocational School of Health Services, Osmaniye Korkut Ata University,

Osmaniye, Türkiye. E-mail: burcusaygidemir@gmail.com ORCID <https://orcid.org/0000-0001-5179-0522>

***** (Corresponding Author) Assoc. Prof., Department of Translational Medicine, Institute of Health Sciences, Çukurova University, Adana, Türkiye ; Department of Pulmonary Diseases, Faculty of Medicine, Çukurova University, Adana, Türkiye. E-mail: ysaygideger@cu.edu.tr ORCID <https://orcid.org/0000-0003-3293-373X>

Keywords: miR-105-5p, *hTERT*, *P53*, *P21*, transfection.

miR-105-5p'nin Çeşitli Kanser Hücre Hatlarında Hücre Proliferasyonu, Koloni Oluşumu ve *hTERT/P53/P21* Gen Ekspresyonuna Etkisi

Öz

Amaç: MikroRNA'lar, protein kodlamayan ancak kanser gelişimini teşvik ederek veya engelleyerek etkileme kapasitesine sahip küçük endojen RNA molekülleridir. Hücre metabolizması, gelişim, apoptoz ve metastazın düzenlenmesinde normal biyolojik roller oynarlar. MikroRNA'ların fonksiyonel mekanizmalarına ilişkin çok sayıda çalışma mevcut olmasına rağmen, miR-105 ailesinin bir üyesi olan miR-105-5p hakkında literatürde sınırlı araştırma bulunmaktadır. Bu çalışma, beş kanser hücresi hattında (A549 (akciğer), Huh7 (karaciğer), HCT116 (kolon), MCF-7 (meme) ve HeLa (serviks)) miR-105-5p'nin hücre çoğalması, koloni oluşumu ve *hTERT*, *P21* ve *P53* genlerinin ekspresyonu üzerindeki etkilerini araştırmıştır.

Yöntem: Seçilen kanser hücre hatlarında miR-105-5p ekspresyonu, transfeksiyon yoluyla hem yukarı hem de aşağı doğru düzenlenmiştir. Transfeksiyondan sonra, hücre çoğalması, koloni oluşturma yeteneği ve *hTERT*, *P21* ve *P53* genlerinin ekspresyonunu değerlendirmek için analizler yapıldı.

Bulgular: miR-105-5p'nin aşırı ekspresyonu tüm kanser hücre hatlarında çoğalmayı inhibe etti. miR-105-5p, A549, MCF-7, HeLa ve Huh7 hücrelerinde koloni oluşumunu baskıladı. miR-105-5p taklidinin etkisi nedeniyle farklı hücre hatlarında *hTERT*, *P53* ve *P21* genlerinin ekspresyon seviyelerinde farklılıklar gözlemlendi.

Sonuç: *hTERT* gen ekspresyon seviyelerindeki doğrudan veya dolaylı farklılıklar, miR-105-5p'nin hedefli tedavide yararlı olabileceğini düşündürmektedir.

Anahtar Sözcükler: miR-105-5p, *hTERT*, *P53*, *P21*, transfeksiyon.

Introduction

MicroRNAs (miRNAs), which regulate mechanisms such as differentiation, proliferation, and apoptosis within the cell, belong to the class of short non-coding RNAs. Genetic variations in miRNA genes can lead to differences in expression levels. Such miRNA-level differences may be linked to cancer and serve as biomarkers¹.

Differences in miRNA expression between normal and cancerous tissues are thought to play a role in cancer development, potentially arising from molecular damage in regions with low amplification². miRNAs may function either as tumor suppressors or oncogenes depending on the cellular context, and a decrease in tumor-suppressive miRNAs that regulate oncogene expression can contribute to enhanced tumor development³. Variations in single nucleotide polymorphisms and mutations have been identified in pri-miRNA, pre-miRNA, and mat-miRNA regions in cancer patients through *in vivo* and *in vitro* studies. While some mutations do not affect miRNA function, mutations in pre-miRNA let-7e (G-A) can decrease miRNA expression⁴. Genetic variations identified in pre-miRNAs include miRNA-146a, miRNA-492, miRNA-499, miRNA-605, miRNA-631, and miRNA-633⁵. Identifying miRNA gene expression and variations in different cancer types is important when creating molecular diagnostics and targeted therapeutic approaches⁶.

Research indicates that miR-105 is involved in diverse oncogenic pathways and may function as a tumor suppressor or oncogene in cancers such as gastric cancer, hepatocellular carcinoma, prostate cancer, and non-small cell lung cancer⁷⁻⁹. The exosomal release of miR-105 by cancer cells has been linked to the promotion of metastasis at distant locations¹⁰. Moreover, miR-105 regulates cell proliferation by targeting CDK6 and plays a key role in the control of epithelial–mesenchymal transition (EMT)¹¹. In breast cancer, it functions as a tumor promoter, contributing to metastatic progression. Its expression is elevated in metastatic lymph nodes and has been correlated with poor prognosis and the presence of lymph node metastasis. In breast cancer, miR-105 can act as a tumor promoter and contribute to metastasis¹². miR-105-5p, a member of the miR-105 family, enhances metastatic potential in melanoma while suppressing proliferation in glioma cells^{8,13}. This microRNA is located on the X chromosome, specifically on the p11.3–q22.3 region, within intron 1 of the GABRA3 gene (gamma-aminobutyric acid A receptor alpha 3 subunit). Owing to its tissue-specific expression and stability in body fluids such as serum, plasma, and urine, miR-105-5p has recently emerged as a promising biomarker for a range of clinical applications, particularly in cancer diagnostics.

The *P21* gene, also known as cyclin-dependent kinase inhibitor 1 or CDK-interacting protein 1, is regulated by the tumor suppressor protein p53. As a cyclin-dependent kinase inhibitor, *P21* can control the cell cycle by inhibiting various cyclin/CDK complexes. By stopping the cell cycle, *P21* allows the cell's DNA to be repaired or, in cases where repair is not possible, to direct the cell to apoptosis¹⁴. With this feature, it can prevent cancer by controlling cell growth. A mutation in the *P53* gene can cause uncontrolled cell growth by reducing *P21* gene expression¹⁵. In addition, *P21* suppresses *hTERT* by binding to its promoter region. *hTERT* is suppressed directly or indirectly via *P21*, and as a result, cell proliferation is inhibited and controlled cell death can be achieved¹⁶.

In silico target prediction analyses using miRDB identified 213 putative targets of hsa-miR-105-5p with a prediction score ≥ 80 , including genes involved in cell cycle regulation (CDC14A, CDC5L, CDK12), apoptotic signalling (FASLG), p53 regulation (MDM4), and oncogenic pathways (KRAS). Notably, MDM4, a key negative regulator of p53, was identified as a high-confidence predicted target (score: 87), providing a plausible mechanistic link between miR-105-5p and the *TP53/P21/hTERT* axis. Complementary analysis using TargetScan further identified SEL1L, FOXP2, and TNFAIP6 among predicted targets. Although TP53, CDKN1A, and TERT were not identified as direct targets, the predicted targeting of MDM4 suggests that miR-105-5p may indirectly modulate p53 activity and downstream *P21/hTERT* expression.

Despite growing interest in miR-105-5p across multiple cancer types, the specific effects of this miRNA on the *P53/P21/hTERT* regulatory axis remain poorly characterised in a systematic, multi-cell-line context. Notably, while Miliotis and Slack (2021)¹⁷ reported an indirect relationship between miR-105-5p and telomerase activity in gastric cancer, their study did not directly investigate *hTERT*, *P53*, or *P21* gene expression across cancer types with distinct *P53* mutational backgrounds, leaving this axis underexplored. The

P21 gene suppresses *hTERT* transcription by binding to its promoter region, and *P53* activates *P21* expression in response to cellular stress; thus, miR-105-5p-mediated regulation of *P53* and *P21* may indirectly influence *hTERT* expression and telomere maintenance. Investigating this axis across cancer cell lines with distinct *P53* mutational backgrounds — wild-type in A549, MCF-7, and HCT116; E6-mediated degradation in HeLa; and Y220C missense mutation in Huh7 — provides a biologically informative framework for evaluating the context-dependent activity of miR-105-5p and represents a comparative approach not previously described in the literature.

Rather than seeking a universal mechanism, this study aimed to compare the cancer-type-specific effects of miR-105-5p overexpression and inhibition on cell proliferation, colony-forming ability, and the expression of *hTERT*, *P21*, and *P53* across five cell lines with distinct *P53* mutational backgrounds, thereby evaluating the context-dependent potential of miR-105-5p as a target in cancer therapy.

Material and Methods

Cell Culture

In this study, hepatocellular carcinoma Huh7 (Cytion, Eppelheim, Germany), colon cancer cell line HCT116 (ATCC, Manassas, Virginia, USA), human non-small cell lung cancer A549 (ATCC, Manassas, Virginia, USA), breast cancer MCF-7 (ATCC, Manassas, Virginia, USA), and cervical cancer HeLa (ATCC, Manassas, Virginia, USA) cell lines were used. Huh7 and HCT116 cells were maintained in RPMI-1640 medium (HyClone, Cat. No: SH30027.01) supplemented with 10% fetal bovine serum (FBS; HyClone, Cat. No: SV30160.03) and 1% penicillin-streptomycin (HyClone, Cat. No: SV30079.01). A549, MCF-7, and HeLa cells were cultured in DMEM (Gibco™, Cat. No: 41966) supplemented with 10% FBS and 1% penicillin-streptomycin. All cell lines were maintained at 37 °C in a humidified incubator with 5% CO₂.

Transfection-Based Modulation of miR-105-5p in Cell Models

Transfection was performed using Lipofectamine 3000 (Invitrogen™, Cat No. L3000015) according to the manufacturer's protocol. Cells at 60–70% confluence were transfected with miR-105-5p mimic (Ambion™; Cat no: 4464066; final concentration: 50 nM), miR-105-5p inhibitor (Ambion™, Cat no: 4464084; 100 nM), or miR-105-5p negative control (Ambion™, Cat no: AM17010; 50 nM) in Opti-MEM™ reduced serum medium. Transfection efficiency was functionally assessed through downstream gene expression changes, which showed consistent and statistically significant responses to mimic and inhibitor conditions across all five cell lines, indirectly confirming successful modulation of miR-105-5p levels. Twenty-four hours after transfection, cells were propagated for proliferation, colony formation, and gene expression experiments. Each experiment was performed with three independent biological replicates (n=3), and all assays were conducted in technical triplicates.

Proliferation Assay

The cells were divided into the wells of 96 plates at 3×10^3 cells/well in 200 μ L medium, and their proliferation was observed at 0, 24, 48, and 72 hours. MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide; BioFROXX) was used for this purpose. 20 μ L MTT (5 mg/mL) was added to each well, and the cells were incubated for 4 hours. Subsequently, the medium was removed, and 50 μ L of isopropanol was added to each well. Following a 15-minute incubation, absorbance was measured at 570 nm using a microplate reader (Biochrom EZ 400).

Colony Formation Experiment

For the colony formation assay, 300 and 500 cells per well were seeded into 6-well plates containing either RPMI or DMEM medium, each supplemented with 10% fetal bovine serum (FBS) and 1% penicillin-streptomycin. Culture media were replenished every two days. After 14 days of incubation, colonies were fixed and stained with a methylene blue solution (0.4 g methylene blue in 50% methanol and 50% distilled water). Stained colonies were imaged under a light microscope using a 20 $\times$ objective. Quantification of colony numbers was performed using ImageJ software (version 1.53a; NIH, USA). Statistical analysis was carried out using GraphPad Prism 8 (GraphPad Software, Inc.).

RNA Isolation from Transfected Cells

RNAs obtained from cells that reached sufficient density after transfection were isolated in accordance with the ELK Biotechnology TRIpure Total RNA Extraction Reagent (EP013), according to the kit protocol. The amounts of RNA obtained were measured and stored at -80°C until used.

Quantitative Polymerase Chain Reaction (PCR) Experiments

The amount of single-stranded RNA obtained from transfected cells was measured on the Quantus Fluorometer (Promega, TM396) using the QuanFluor® RNA Sample Kit (E3311). 1 μ g of total RNA per sample was used for cDNA synthesis according to the protocol of the abm One Script® cDNA Synthesis Kit from each RNA sample. Primers were designed using the IDT PrimerQuest Tool (<https://eu.idtdna.com/PrimerQuest/Home/Index>). Polymerase chain reactions (PCR) were carried out in an Eppendorf Mastercycler using cDNA templates, SYBR Green mix (Sigma Aldrich), and the primers listed in Table 1. All reactions were performed in triplicate in a 96-well plate (100 μ L) using a Bio-Rad iCycler system. The difference between the Ct (cycle threshold) value obtained for each well as a result of PCR and the conditions was calculated using the formula $2^{-\Delta\Delta CT}$ after normalizing with the 18S internal control. Statistical comparisons were performed using one-way ANOVA followed by Tukey's post-hoc test; $p < 0.05$ was considered statistically significant.

Table 1. Designed primers.

GEN	SEQUENCES
<i>18S</i>	forward: 5'-CTTAGAGGGACAAGTGGCG-3'
	reverse: 5'-ACGCTGAGCCAGTCAGTGTA-3'
<i>P21</i>	forward: 5'-CCCGTGAGCGATGGAACT-3'
	reverse: 5'-CGAGGCACAAGGGTACAAGA-3'
<i>P53</i>	forward: 5'-AGGGATGTTTGGGAGATGTAAG-3'
	reverse: 5'-CCTGGTTAGTACGGTGAAGTC-3'
<i>hTERT</i>	forward: 5'-CCCATTTTCATCAGCAAGTTTGG-3'
	reverse: 5'-CTTGGCTTTCAGGATGGAGTAG-3'

In Silico Target Prediction Analysis

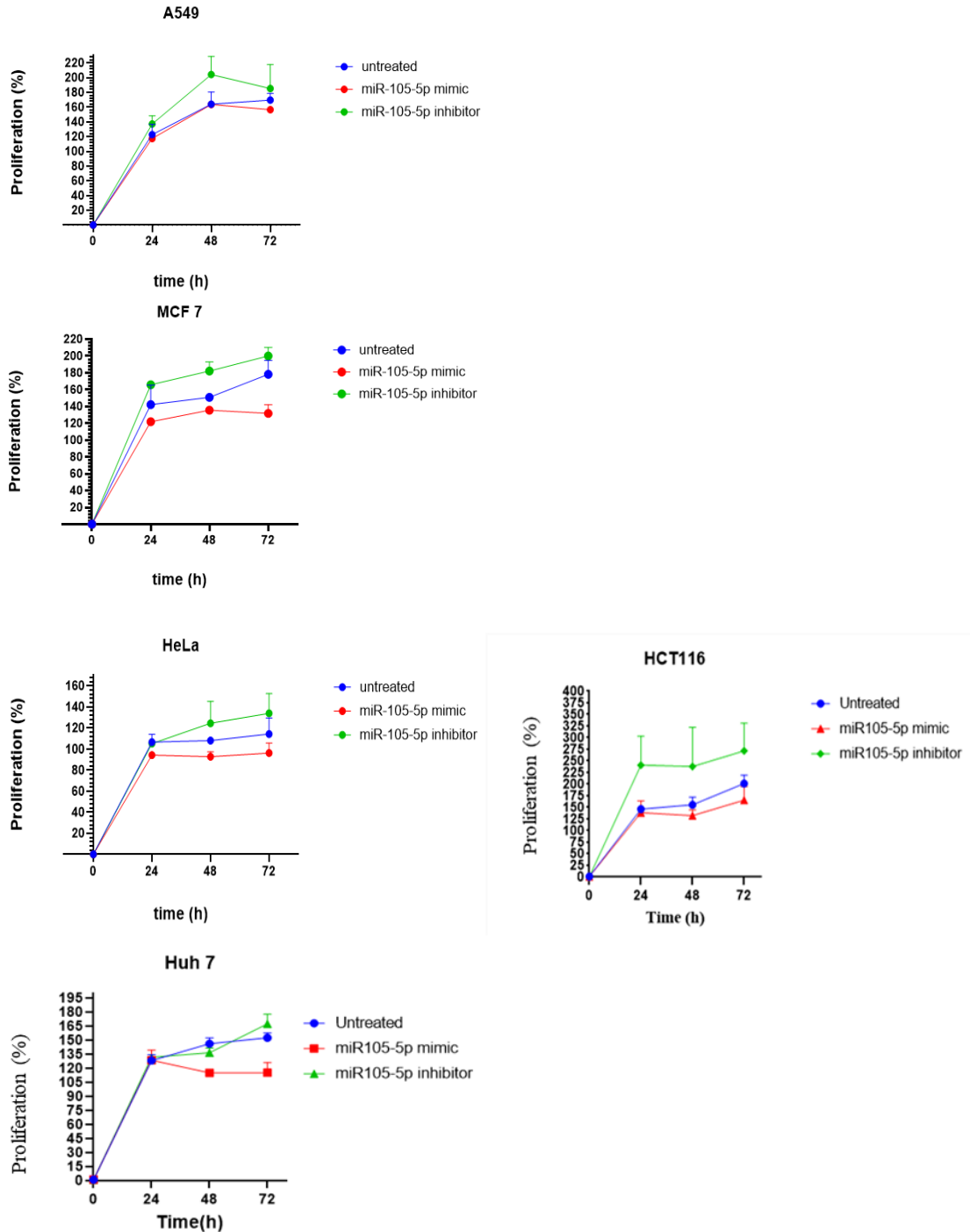
Putative targets of hsa-miR-105-5p were identified using miRDB (www.mirdb.org) and TargetScan (www.targetscan.org). Targets with a miRDB prediction score ≥ 80 were considered for further evaluation. Results from both databases were compared to identify overlapping predictions.

Results

miR-105-5p Mediates Growth Suppression in Various Cancer Cell Lines

The oncogenic or tumor-suppressive properties of miR-105-5p were determined by 24-, 48- and 72-hour proliferation analysis. Overexpression of miR-105-5p (mimic) was achieved by transfection in A549, HeLa, HCT116, Huh7, and MCF-7 cells. With miR-105-5p mimic transfection, proliferation levels of cancer cells decreased compared to negative control and inhibition groups ($P < 0.05$) (Figure 1). In A549, HeLa, HCT116, Huh7, and MCF-7 cells, where miR-105-5p expression was suppressed by transfection (inhibition), proliferation levels increased significantly compared to mimic and negative control groups ($P < 0.05$) (Figure 1).

Figure 1. Researchers analyzed the proliferation rates of Huh7, HCT116, A549, MCF-7, and HeLa cells that were transfected with miR-105-5p mimic, miR-105-5p inhibitor, and negative control. Overexpression of miR-105-5p significantly decreased proliferation in all tested cancer cell lines.

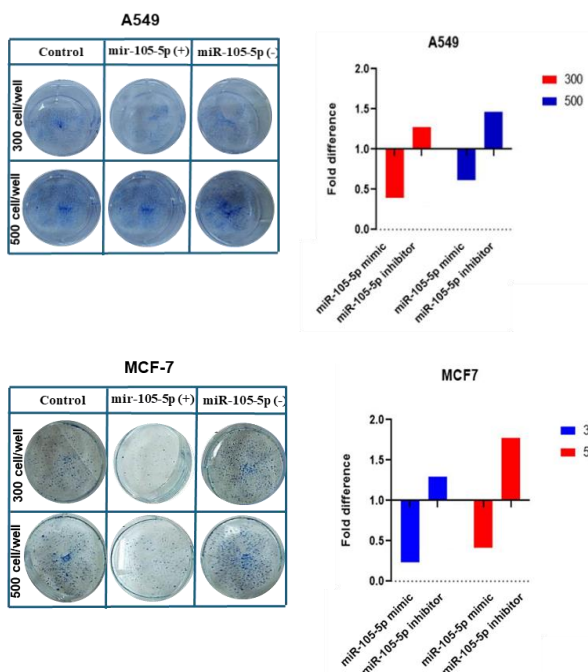


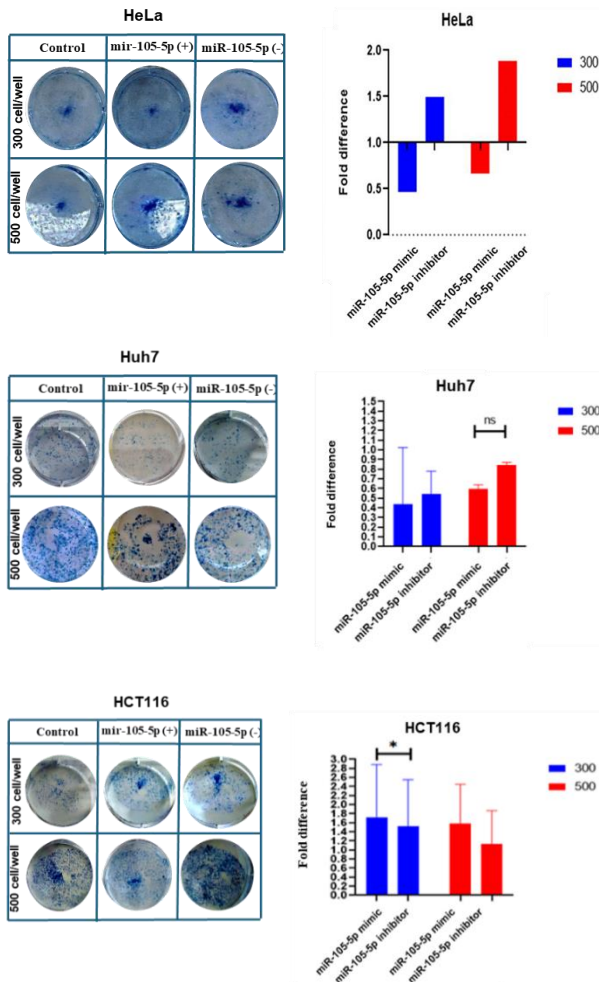
Inhibitory Role of miR-105-5p on Clonogenic Potential

The effects of overexpression and inhibition of miR-105-5p on the colony-forming properties of Huh7, HCT116, A549, MCF-7 and HeLa cells were examined. Colonies formed after incubation were analyzed using the GraphPad 9 program, and graphics were created. When miR-105-5p expression was increased, colony formation was suppressed in parallel with the proliferation of cells in A549, MCF-7 and HeLa cell lines (Figure 2). Inhibition of miR-105-5p resulted in enhanced colony formation across all cell lines relative to the negative control and miR-105-5p overexpression groups (Figure 2). In Huh7 cells, fewer colonies formed in the overexpression and inhibitor groups than in the negative control. In addition, colonization in the overexpression and inhibitor groups was close to each other, but inhibitor cells formed more colonies than mimic cells.

Colony formation in HCT116 cells, where miR-105-5p was overexpressed and suppressed, increased compared to the negative control group ($P>0.0657$ and $P>0.1103$).

Figure 2. Colony formation assay results and representative images of A549, MCF-7, and HeLa cells transfected with miR-105-5p mimic, miR-105-5p inhibitor, and negative control. Overexpression of miR-105-5p significantly reduced colony formation in these cell lines.





The expression levels of hTERT, P21, and P53 varied in cells transfected with miR-105-5p.

The effects of miR-105-5p expression on hTERT-associated gene regulation in A549, MCF-7, HeLa, Huh7, and HCT116 cell lines were investigated by examining changes in *hTERT*, *P53*, and *P21* gene expression levels. In A549 cells transfected with the miR-105-5p mimic, *hTERT* and *P53* gene expression levels increased, while *P21* expression levels decreased. Inhibition of miR-105-5p in A549 cells increased *P21* gene expression while decreasing *hTERT* gene expression (Figure 3).

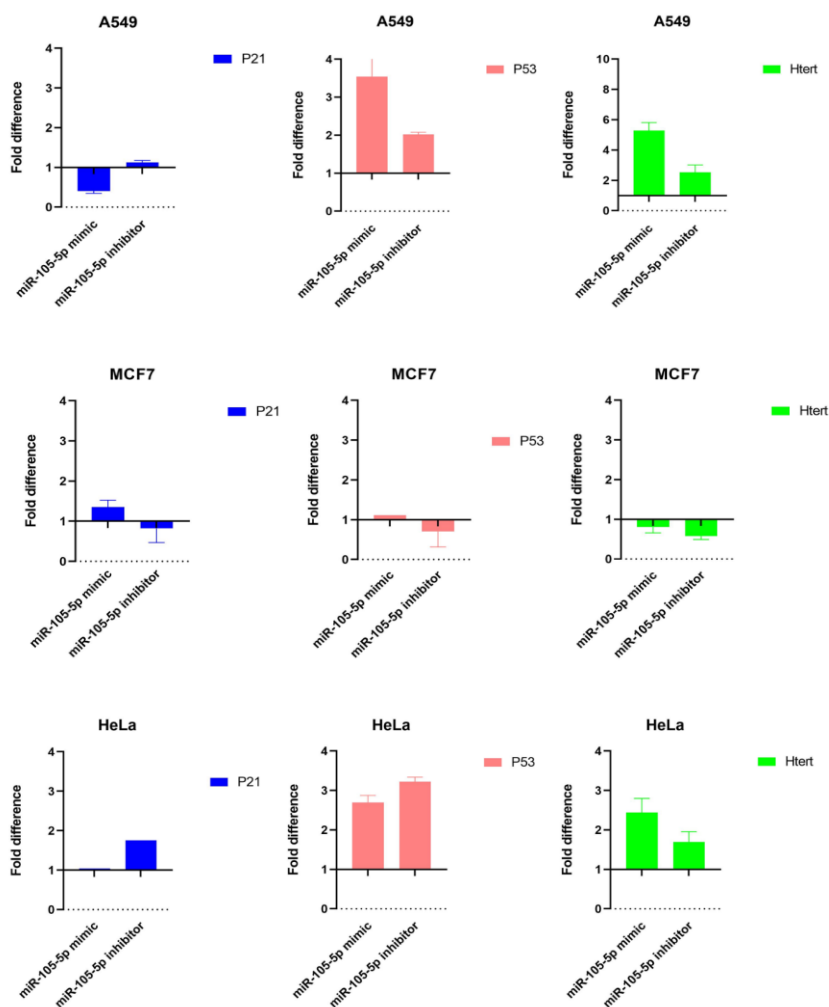
In miR-105-5p mimic MCF-7 cells, *P21* and *P53* gene expression increased, but the *hTERT* gene expression level decreased. There was a decrease in *P21*, *P53* and *hTERT* gene expressions in cells where miR-105-5p was inhibited (Figure 3).

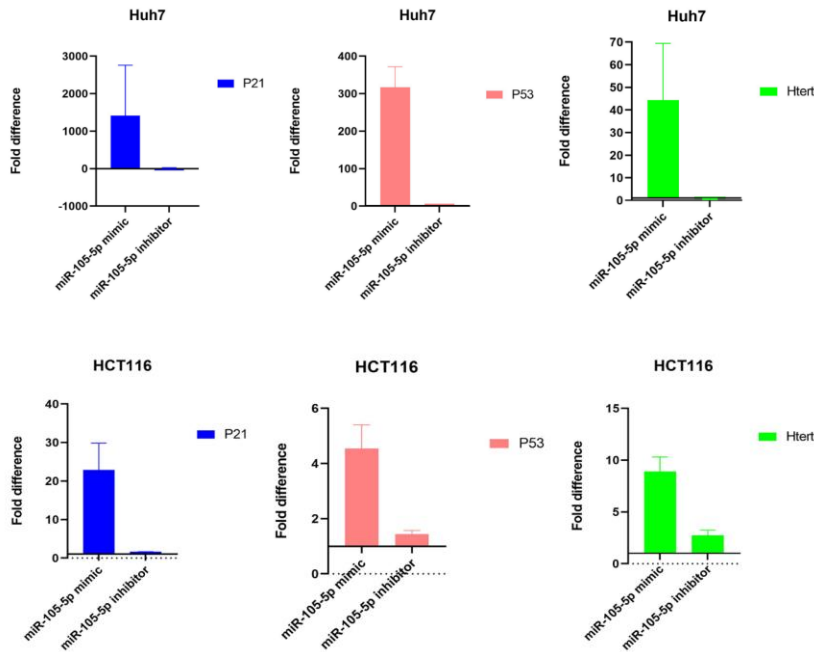
With overexpression of miR-105-5p, *P21*, *P53*, and *hTERT* gene expressions increased in HeLa cells. In HeLa cells where miR-105-5p was inhibited, *P21* and *P53* increased, while *hTERT* decreased relatively (Figure 3).

In Huh7 cells, *hTERT*, *P53*, and *P21* gene expression levels increased when miR-105-5p was overexpressed but remained at low levels when it was inhibited (Figure 3).

In HCT116 cells, *P21*, *P53*, and *hTERT* gene expression levels increased with overexpression of miR-105-5p. By inhibiting miR-105-5p, *P21*, *P53*, and *hTERT* levels were expressed less than in the mimic group (Figure 3).

Figure 3. In all cancer cell lines transfected with miR-105-5p mimic or inhibitor, the expression levels of *hTERT*, *P53*, and *P21* were normalized to the 18S internal control, and data analysis was performed using GraphPad Prism 8.4.3. Overexpression and suppression of miR-105-5p elicited variable effects on gene expression across the different cell lines.





***Gene expression levels are presented as fold change relative to the negative control group ($2^{\Delta\Delta CT}$ method). A value of 1.0 represents the negative control baseline.**

In Silico Target Prediction of miR-105-5p

miRDB analysis identified 213 putative targets of hsa-miR-105-5p with a prediction score ≥ 80 . Among these, *MDM4* (score: 87), *FASLG* (score: 91), *CDC14A* (score: 86), *CDK12* (score: 87), and *KRAS* (score: 81) were identified as biologically relevant predicted targets. TargetScan analysis additionally predicted *SEL1L*, *FOXP2*, and *TNFAIP6* as putative targets. The predicted targeting of *MDM4* is of particular interest given its role as a negative regulator of p53, suggesting a potential indirect mechanism through which miR-105-5p may influence the *TP53/P21/hTERT* axis.

Discussion

MiRNAs are effective as oncogenic and tumor suppressors in many metabolic pathways associated with cancer (such as proliferation, differentiation, cell cycle, and apoptosis)¹⁸⁻²⁰. In this study, the effects of miR-105-5p, which belongs to the miRNA family, on proliferation, colony formation, and especially the Human Telomerase Reverse Transcriptase (*hTERT*) gene expression levels in relation to *P21* and *P53* in various cancer cell lines were investigated.

Increasing miR-105-5p expression suppressed proliferation in hepatocellular carcinoma, colon, breast, and cervical cancer cell lines. When miR-105-5p expression was suppressed, the proliferation rate increased significantly compared to the control group.

The antiproliferative effect of miR-105-5p in this study suggests that it may play a role as a tumor suppressor and may be a potential target for these cell lines in targeted treatment approaches. The level of miRNA should be evaluated individually for each type of cancer. Some types of cancer may develop due to overexpression of miRNAs. For our study, overexpression of miR-105-5p suppressed the proliferation of cancer cells. Numerous studies align with our findings, suggesting that cancer tissues exhibit lower expression of miRNAs and that carcinogenesis suppresses miRNAs^{12,21}. Dong et al. also determined that upregulation of miR-105-5p suppressed proliferation in lung cell lines²². Contrary to this study, in another study, the increase of miR-105-5p in bladder cancer stem cells was associated with proliferation²³.

The overexpression of miR-1298, miR-3180-3p, miR-545, and miR-186 led to the inhibition of cell proliferation in non-small cell lung cancer (NSCLC) cells²⁴⁻²⁸. MiR-1298 reduced the proliferation of MCF-7 cells [24]. Researchers have reported that miR-423-5p enhances programmed cell death and reduces the proliferative, migratory, and invasive capabilities of HCT116 cells²⁹. Similarly, miR-200b and miR-214 suppressed proliferation in HeLa cells^{30,31}. Huh-7 cells overexpressed miR-296-3p, which inhibited proliferation, migration, and invasion while promoting cell death³¹.

Researchers determined how the suppression and overexpression of miR-105-5p affected colony formation in lung, hepatocellular carcinoma, colon, breast, and cervical cancer cell lines using a colony formation assay. Overexpression of miR-105-5p significantly suppressed colony formation, except in the HCT116 cell line. Colony formation increased significantly with suppression of miR-105-5p (except for the HCT116 cell line). In cases where miR-105-5p was suppressed and overexpressed in HCT116 cells, the colony increase was higher than in the control groups. Additionally, overexpression increased colony formation, unlike other cell lines. In HCT116 cells, both suppression and overexpression of miR-105-5p lead to increased colony formation, highlighting the context-specific and complex role of this miRNA in colorectal cancer cell proliferation. This dual effect is believed to be related to miR-105-5p's interaction with multiple target genes and signaling pathways that regulate cell growth and colony formation²⁸. In HCT116 cells, miR-423-3p promoted colony formation, while inhibiting it significantly reduced this process³². MiR-214 inhibited the colony-forming ability of HeLa cells, suggesting its potential role in reducing the malignancy of cervical cancer cells³¹. Furthermore, the overexpression of miR-296-3p inhibited colony formation in HCC (Huh7) cells³³. These findings underscore the important role of miRNAs in regulating colony formation and cancer cell proliferation.

The relationship between miR-105-5p expression and the regulation of *hTERT*, *P53*, and *P21* was examined across lung, hepatocellular carcinoma, colon, breast, and cervical cancer cell lines. The induction of *hTERT* can significantly stabilize telomeres and trigger malignant processes like migration, metastasis, and angiogenesis³⁴. Therefore, targeted treatment of *hTERT* offers an option in many types of cancer. Accordingly, increasing-decreasing expressions of miRNAs can suppress tumor growth by affecting *hTERT* activity³⁵. The *P21* gene, whose expression is controlled by the *P53* gene, serves as the

control mechanism of a cell cycle. As a result of abnormalities in cell division, *P53* allows *P21* gene expression to increase, thus stopping the cell cycle and allowing the control mechanism to work³⁶. Elevated levels of *P21* can bind to the promoter region of the *hTERT* gene, leading to direct repression of its expression. *P53*, a well-known tumor suppressor gene, is frequently mutated across various cancer types³⁷. Such mutations may result in altered expression—either upregulation or downregulation—of genes regulated directly or indirectly by *P53*. Consequently, these changes can disrupt critical cellular processes, including cell cycle regulation, apoptosis, and DNA repair mechanisms³⁸.

In A549 cells, the miR-105-5p mimic increased the expression levels of *hTERT* and *P53* genes while simultaneously suppressing the expression of the *P21* gene. Induction of the *P53* gene is directly proportional to suppression of proliferation and colony formation. However, decreased *P21* expression prevented suppression of *hTERT*. It is obvious that *P53* does not lead to cell death by binding to *P21*. Like some other miRNAs, miR-105-5p changed the expression levels of *P21*. The finding that miR-105-5p binds to the gene via the 3'UTR and down-regulates *P21* is consistent with another study in the literature³⁹. The lack of a significant difference in the level of *P21* regulated by *P53* in the presence of miR-105-5p suggests that it may be mutated. In lung cancer, in the absence of miR-105-5p, *P21* acts as an oncogene; in the presence of miR-105-5p, *P53* and *hTERT* function as tumor suppressors.

In the breast cancer cell line MCF-7, miR-105-5p suppressed the expression level of *hTERT* while simultaneously increasing the expression levels of *P21* and *P53*. Increased *P53* levels are known to upregulate *P21* gene expression, leading to cell cycle arrest and potentially apoptotic signalling, though direct apoptosis was not assessed in this study. Additionally, *P21* suppressed *hTERT*, thereby inhibiting cell proliferation. The decreased *hTERT* level in the absence of miR-105-5p should be supported by additional experiments. In breast cancer, miR-105-5p did not affect *hTERT* gene expression, while the *P53* and *P21* genes acted as tumor suppressors in its presence.

MiR-105-5p increased the expression levels of *hTERT*, *P53*, and *P21* genes in the human cervical cancer cell line HeLa. However, either directly or indirectly, increased *P53* could not suppress *hTERT* levels. It is postulated that *P53* may indirectly suppress proliferation and colony formation through pro-apoptotic signalling, though this was not directly assessed in the present study. In cervical cancer cells, when miR-105-5p is expressed, *hTERT* shows a tumor suppressor effect, while when miR-105-5p is inhibited, the *P53* and *P21* genes show an oncogene effect.

It was determined that miR-105-5p caused a significant increase in *hTERT*, *P53*, and *P21* levels in hepatocellular cancer cell lines. Although increased *P53* and *P21* expressions prevented proliferation in cells, there was no significant decrease or increase in colony formation compared to control groups. However, when miR-105-5p was suppressed, *hTERT* levels decreased. This suggests that miR-105-5p has oncogenic properties for Huh7 cells. The Y220C missense mutation in *TP53* in Huh7 cells results in a structurally destabilised protein with impaired transactivation capacity, explaining the inability of

mutant *P53* to effectively suppress *hTERT* expression via *P21* upregulation. In this context, mutant *P53* may acquire gain-of-function oncogenic properties that sustain *hTERT* expression and colony formation, consistent with the gain-of-function mutant *P53* phenotype described in the literature.

In colon cancer cells, miR-105-5p induced an increase in the expression levels of the *hTERT*, *P53*, and *P21* genes. The upregulation of *P53* and *P21* significantly inhibited proliferation in HCT116 cells, whereas proliferation was enhanced when miR-105-5p was absent. Interestingly, the observed increase in *hTERT*—contrary to the expected decrease—suggests that miR-105-5p may exert anti-proliferative effects through an alternative mechanism. Furthermore, the elevated *hTERT* expression might explain the lack of a significant impact of miR-105-5p on colony formation. The unexpected increase in *hTERT* expression in HCT116 cells, despite concurrent upregulation of *P53* and *P21*, may reflect the activation of alternative *hTERT* regulatory pathways operating independently of the *P53/P21* axis — such as c-Myc-mediated transcriptional activation or epigenetic deregulation of the *hTERT* promoter — and warrants further mechanistic investigation. The simultaneous increase in colony formation upon both overexpression and inhibition of miR-105-5p in HCT116 cells suggests that this cell line may be particularly sensitive to perturbations in miRNA homeostasis, regardless of direction. One possible explanation is that miR-105-5p targets multiple genes with opposing functions in HCT116 cells, such that both its overexpression and its inhibition disrupt the balance of pro- and anti-tumorigenic signals, ultimately favouring colony growth. Furthermore, HCT116 cells harbour wild-type *TP53* but also carry an activating *KRAS* mutation, which is a predicted target of miR-105-5p (miRDB score: 81). It is plausible that miR-105-5p-mediated suppression of *KRAS* signalling in the mimic condition partially counteracts the expected tumour-suppressive effects of elevated *P53* and *P21*, resulting in the paradoxical increase in colony formation despite reduced proliferation. The concurrent elevation of *hTERT* in this context may reflect *KRAS*-driven transcriptional activation of the *hTERT* promoter, which is known to operate independently of the *P53/P21* axis. Taken together, the HCT116 data highlight the complex, context-dependent nature of miR-105-5p function in colorectal cancer and underscore the need for further mechanistic studies in this cell line.

This study has a number of limitations that should be taken into account when interpreting the findings. To begin with, direct qPCR quantification of miR-105-5p levels after mimic and inhibitor transfection was not carried out, so successful modulation of miR-105-5p could not be formally verified. Instead, transfection efficacy was inferred from the downstream changes in *hTERT*, *P21*, and *P53* expression, which were consistent and statistically significant across all five cell lines. Beyond this, apoptosis was not directly measured; the upregulation of *P53* and *P21* alongside downregulation of *hTERT* were taken as indirect indicators of a potential pro-apoptotic response, rather than as definitive evidence. Telomerase enzymatic activity was likewise not assessed; *hTERT* mRNA levels served as a proxy, which may not accurately reflect protein-level activity. Protein expression was not examined by western blotting or similar methods, meaning transcript-level changes may not correspond directly to changes in protein abundance.

In addition, baseline miR-105-5p expression in these cell lines relative to normal counterparts was not measured before transfection, which limits the physiological relevance of the findings. Finally, the variable responses across cell lines, particularly in HCT116 and Huh7, most likely reflect the distinct *TP53* mutational backgrounds and signalling contexts of each model, and should not be generalised as a uniform miR-105-5p mechanism.

Conclusion

In some cancer cells, miR-105-5p promotes cell cycle arrest, anti-proliferative effects, and senescence, while in others, it can have oncogenic effects. In A549, MCF-7, and HCT116 cells, miR-105-5p caused anti-proliferative effects associated with increased non-mutant *P53* levels, while it prevented colony formation. These findings are consistent with a potential role for miR-105-5p in modulating *P53* expression, though this warrants further experimental validation. There are studies reporting that some miRNAs exhibit high expression in tumors, bind to the 3'UTR of *P53*, and inhibit *P53* levels^{39,40}. However, the same is not the case for miR-105-5p. In cervical cancer, where the E6 oncoprotein-dependent *P53* degradation pathway is active⁴¹, mutated *P53* was already inhibited together with miR-105-5p expression and could not show tumor suppressor properties. The elevated level of mutant *P53*, resulting from the mutation that changed tyrosine 220 to cysteine in Huh7 cells, was unable to prevent colony formation and did not act as a suppressive element on *hTERT*. Inhibition of miR-105-5p was associated with increased mutated *P53* levels in HeLa cells, consistent with a potential gain-of-function oncogenic role of mutant *P53* in this context; however, this interpretation requires further experimental validation. These findings suggest that the expected *P53*-mediated tumour suppressor response was not observed in HeLa cervical cancer cells, most likely because the HPV-encoded E6 oncoprotein constitutively targets *P53* for proteasomal degradation in this cell line, preventing its accumulation regardless of miR-105-5p modulation. The substantial heterogeneity observed across cell lines underscores that miR-105-5p does not act through a single universal mechanism, and its effects are likely shaped by the specific molecular background of each cancer type, including *P53* mutational status and downstream regulatory networks.

In light of the data of this study, miR-105-5p gene expression, which varies in different types of cancer, suggests that it may be a beneficial marker in targeted therapy.

Acknowledgements: We would like to thank the Scientific Research Unit of Çukurova University for their support in the conduct of this study with projects numbered FYL-2021-14344 and BAP: TYL-2021-13415. We would also like to thank the Central Laboratory and Biotechnology Center of Cukurova University for providing space and equipment for conducting of the experimental stages of the project.

Author Contributions: The first two authors co-contributed to the article and are both listed as first authors.

Conflict of Interest Statement: The authors have declared that there is no conflict of interest.

Ethical Approval: This study includes cell culture experiments and does not require ethics committee approval since it does not include animal or human samples.

REFERENCES

1. Ratti M, Lampis A, Ghidini M, et al. MicroRNAs (miRNAs) and long Non-Coding RNAs (lncRNAs) as new tools for cancer therapy: First steps from bench to bedside. *Target Oncol.* 2020;15(3):261-78. doi: 10.1007/s11523-020-00717-x.
2. Smolarz B, Durczyński A, Romanowicz H, Szyłło K, Hogendorf P. miRNAs in cancer (review of literature). *Int J Mol Sci.* 2022;23(5). doi: 10.3390/ijms23052805.
3. Otmami K, Lewalle P. Tumor suppressor miRNA in cancer cells and the tumor microenvironment: Mechanism of deregulation and clinical implications. *Front Oncol.* 2021;11:708765. doi: 10.3389/fonc.2021.708765.
4. Slaby O, Bienertova-Vasku J, Svoboda M, Vyzula R. Genetic polymorphisms and microRNAs: New direction in molecular epidemiology of solid cancer. *J Cell Mol Med.* 2012;16(1):8-21. doi: 10.1111/j.1582-4934.2011.01359.x.
5. Landi D, Gemignani F, Barale R, Landi S. A catalog of polymorphisms falling in microRNA-binding regions of cancer genes. *DNA Cell Biol.* 2008;27(1):35-43.
6. Seyhan AA. Trials and tribulations of MicroRNA therapeutics. *Int J Mol Sci.* 2024;25(3).
7. Khan S, Zhang DY, Zhang JY, et al. The key role of microRNAs in initiation and progression of hepatocellular carcinoma. *Front Oncol.* 2022;12:950374.
8. Li J, Zhang Z, Chen F, et al. The diverse oncogenic and tumor suppressor roles of microRNA-105 in cancer. *Front Oncol.* 2019;9:518.
9. Lu G, Fu D, Jia C, et al. Reduced miR-105-1 levels are associated with poor survival of patients with non-small cell lung cancer. *Oncol Lett.* 2017;14(6):7842-8.
10. Zhou W, Fong MY, Min Y, et al. Cancer-secreted miR-105 destroys vascular endothelial barriers to promote metastasis. *Cancer Cell.* 2014;25(4):501-15.

11. Shang JC, Yu GZ, Ji ZW, Wang XQ, Xia L. MiR-105 inhibits gastric cancer cells metastasis, epithelial-mesenchymal transition by targeting SOX9. *Eur Rev Med Pharmacol Sci.* 2019;23(14):6160-9. doi: 10.26355/eurev_201907_18429.
12. Lin S, Gregory RI. MicroRNA biogenesis pathways in cancer. *Nat Rev Cancer.* 2015;15(6):321-33. doi: 10.1038/nrc3932.
13. Gao R, Wang Z, Liu Q, Yang C. MicroRNA-105 plays an independent prognostic role in esophageal cancer and acts as an oncogene. *Cancer Biomark.* 2020;27(2):173-80.
14. Al Bitar S, Gali-Muhtasib H. The role of the cyclin dependent kinase inhibitor p21(cip1/waf1) in targeting cancer: Molecular mechanisms and novel therapeutics. *Cancers (Basel).* 2019;11(10). doi: 10.3390/cancers11101475.
15. Wang H, Guo M, Wei H, Chen Y. Targeting P53 pathways: Mechanisms, structures and advances in therapy. *Signal Transduction and Targeted Therapy.* 2023;8(1):92.
16. Henderson YC, Breau RL, Liu TJ, Clayman GL. Telomerase activity in head and neck tumors after introduction of wild-type P53, P21, p16, and E2F-1 genes by means of recombinant adenovirus. *Head Neck.* 2000;22(4):347-54.
17. Miliotis C, Slack FJ. miR-105-5p regulates PD-L1 expression and tumor immunogenicity in gastric cancer. *Cancer Lett.* 2021;518:115-126. doi: 10.1016/j.canlet.2021.05.037.
18. Davis-Dusenbery BN, Hata A. MicroRNA in cancer: The involvement of aberrant microRNA biogenesis regulatory pathways. *Genes Cancer.* 2010;1(11):1100-14.
19. Menon A, Abd-Aziz N, Khalid K, Poh CL, Naidu R. miRNA: A promising therapeutic target in cancer. *Int J Mol Sci.* 2022;23(19). doi: 10.3390/ijms231911502.
20. Zhang B, Pan X, Cobb GP, Anderson TA. microRNAs as oncogenes and tumor suppressors. *Dev Biol.* 2007;302(1):1-12. doi: 10.1016/j.ydbio.2006.08.028.
21. Fasoulakis Z, Daskalakis G, Diakosavvas M, et al. MicroRNAs determining carcinogenesis by regulating oncogenes and tumor suppressor genes during cell cycle. *Microna.* 2020;9(2):82-92. doi: 10.2174/2211536608666190919161849.
22. Dong B, Zhang F, Zhang W, Gao Y. lncRNA EPB41L4A-AS1 mitigates the proliferation of non-small-cell lung cancer cells through the mir-105-5p/gmap6 axis. *Crit Rev Eukaryot Gene Expr.* 2023;33(2):27-40.

- 23.** Pan G, Jiang B, Yi Z, Yin J, Liu Y. Exosomal miR-105-5p derived from bladder cancer stem cells targets for GPR12 to promote the malignancy of bladder cancer. *BMC Urol.* 2023;23(1):155. doi: 10.1186/s12894-023-01326-2.
- 24.** Chen T, Liu Y, Chen J, et al. Exosomal miR-3180-3p inhibits proliferation and metastasis of non-small cell lung cancer by downregulating FOXP4. *Thorac Cancer.* 2021;12(3):372-81. doi: 10.1111/1759-7714.13759.
- 25.** Chen W, Lu Q, Li S, Zhang X, Xue X. microRNA-1298 inhibits the malignant behaviors of breast cancer cells via targeting ADAM9. *Biosci Rep.* 2020;40(12).
- 26.** Cui G, Cui M, Li Y, et al. MiR-186 targets ROCK1 to suppress the growth and metastasis of NSCLC cells. *Tumour Biol.* 2014;35(9):8933-7. doi: 10.1007/s13277-014-2168-6.
- 27.** Cui J, Pan G, He Q, et al. MicroRNA-545 targets ZEB2 to inhibit the development of non-small cell lung cancer by inactivating Wnt/ β -catenin pathway. *Oncol Lett.* 2019;18(3):2931-8. doi: 10.3892/ol.2019.10619.
- 28.** Wang CJ, Stratmann J, Zhou ZG, Sun XF. Suppression of microRNA-31 increases sensitivity to 5-FU at an early stage, and affects cell migration and invasion in HCT-116 colon cancer cells. *BMC Cancer.* 2010;10:616. doi: 10.1186/1471-2407-10-616.
- 29.** Cheng Z, Jiang S, Tao R, Ge H, Qin J. Activating transcription factor 3-activated long noncoding RNA forkhead box P4-antisense RNA 1 aggravates colorectal cancer progression by regulating microRNA-423-5p/nucleus accumbens associated 1 axis. *Bioengineered.* 2022;13(2):2114-29. doi: 10.1080/21655979.2021.2023798.
- 30.** He L, Wang J, Chang D, et al. Effect of miRNA-200b on the proliferation and apoptosis of cervical cancer cells by targeting RhoA. *Open Med (Wars).* 2020;15(1):1019-27.
- 31.** Wen Z, Lei Z, Jin-An M, et al. The inhibitory role of miR-214 in cervical cancer cells through directly targeting mitochondrial transcription factor A (TFAM). *Eur J Gynaecol Oncol.* 2014;35(6):676-82.
- 32.** Ma J, Yan H, Zhang J, Tan Y, Gu W. Long-Chain Non-Coding RNA (lncRNA) MT1JP suppresses biological activities of lung cancer by regulating miRNA-423-3p/Bim Axis. *Med Sci Monit.* 2019;25:5114-26. doi: 10.12659/msm.914387.
- 33.** Li X, An M, Gao Z. In Hepatocellular carcinoma, mirna-296-3p targets msl2 and suppresses cell proliferation and invasion. *J Oncol.* 2021;2021:7430468.
- 34.** Dogan F, Forsyth NR. Telomerase regulation: A role for epigenetics. *Cancers (Basel).* 2021;13(6). doi: 10.3390/cancers13061213.

35. Salamati A, Majidinia M, Asemi Z, et al. Modulation of telomerase expression and function by miRNAs: Anti-cancer potential. *Life Sci.* 2020;259:118387.
36. Marei HE, Althani A, Afifi N, et al. *P53* signaling in cancer progression and therapy. *Cancer Cell Int.* 2021;21(1):703. doi: 10.1186/s12935-021-02396-8.
37. Yao Y, Bellon M, Shelton SN, Nicot C. Tumor suppressors *P53*, p63TAA, p63TAY, p73 α , and p73 β use distinct pathways to repress telomerase expression. *J Biol Chem.* 2012;287(24):20737-47. doi: 10.1074/jbc.M111.319236.
38. Fang SS, Guo JC, Zhang JH, et al. A *P53*-related microRNA model for predicting the prognosis of hepatocellular carcinoma patients. *J Cell Physiol.* 2020;235(4):3569-78.
39. Jung SJ, Park JH, Hwang I, Lee JH. Different *TERT* expression between colorectal adenoma and serrated polyp. *Medicina (Kaunas).* 2020;56(9).
40. Jones M, Lal A. MicroRNAs, wild-type and mutant *P53*: More questions than answers. *RNA Biol.* 2012;9(6):781-91. doi: 10.4161/rna.20146
41. Hengstermann A, Linares LK, Ciechanover A, Whitaker NJ, Scheffner M. Complete switch from Mdm2 to human papillomavirus E6-mediated degradation of *P53* in cervical cancer cells. *Proc Natl Acad Sci USA.* 2001;98(3):1218-23. doi: 10.1073/pnas.98.3.1218.

Hypertension-Related Microstructural Changes in the Vitreous Humor Detected by Diffusion MRI

Davut Ünsal ÇAPKAN*

Abstract

Aim: Hypertension is known to affect several target organs through chronic microvascular injury. Although ocular involvement is usually assessed by retinal or choroidal vascular findings, possible changes in the vitreous humor have received limited attention. This study investigated whether diffusion-weighted magnetic resonance imaging (DW-MRI) could detect hypertension-related alterations in the vitreous humor by measuring apparent diffusion coefficient (ADC) values.

Method: This retrospective cross-sectional study included 100 patients with hypertension and 100 controls frequency matched to the hypertension group according to age and sex who had undergone orbital DW-MRI. Vitreous humor ADC values were measured on ADC maps using standardized regions of interest (ROI). Right, left, and mean ADC values were compared between groups. Multivariable linear regression was used to determine factors independently associated with mean ADC. Within-sample discriminative performance was explored using receiver operating characteristic (ROC) analysis. Intra-observer reliability was evaluated with intraclass correlation coefficients.

Results: Mean vitreous ADC was significantly lower in participants with hypertension than in controls (2.18 ± 0.20 vs. $2.32 \pm 0.18 \times 10^{-3} \text{ mm}^2/\text{s}$; $p < 0.001$), with a moderate-to-large effect size (Cohen's $d = 0.72$). In multivariable analysis, hypertension remained independently associated with lower mean ADC after adjustment for age, sex, and diabetes mellitus ($B = -0.160$, 95% CI: -0.210 to -0.110 ; standardized $\beta = -0.42$; $p < 0.001$). Mean ADC showed the highest within-sample discrimination among the evaluated measures (AUC = 0.83, 95% CI: 0.77–0.89), with a data-derived cut-off of $\leq 2.25 \times 10^{-3} \text{ mm}^2/\text{s}$, 78.0% sensitivity, and 75.0% specificity. Age was inversely correlated with mean ADC ($r = -0.34$, $p < 0.001$). Intra-observer reproducibility was excellent for mean ADC measurements (ICC = 0.96, 95% CI: 0.94–0.97).

Conclusion: Patients with hypertension had lower vitreous ADC values than controls, which may reflect subtle differences in vitreous microstructure. Although mean ADC showed within-sample discrimination between hypertensive participants and controls, these exploratory findings do not establish vitreous ADC as a clinical diagnostic test. Prospective multicenter studies incorporating comprehensive ophthalmological assessments and external validation are required to clarify the clinical relevance of these findings.

Keywords: Hypertension, ocular microstructure, vitreous humor, imaging biomarker, apparent diffusion coefficient, diffusion-weighted MRI.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 29.04.2026 **Kabul / Accepted:** 13.08.2026

DOI: <https://doi.org/10.38079/igusabder.1939863>

* Asst. Prof. Dr., Department of Radiology, Medical Point Hospital, Gaziantep, Türkiye.

E-mail: drdavutunsal11@gmail.com [ORCID https://orcid.org/0009-0007-6937-8799](https://orcid.org/0009-0007-6937-8799)

ETHICAL STATEMENT: The study protocol was approved by the Gaziantep City Hospital Non-Interventional Clinical Research Ethics Committee, Gaziantep, Türkiye (Number: 445/2026, Date: 06.03.2026).

Hipertansiyon ile İlişkili Vitreus Humerusta Mikroyapısal Değişikliklerin Difüzyon MRG ile Değerlendirilmesi

Öz

Amaç: Hipertansiyonun kronik mikrovasküler hasar yoluyla çeşitli hedef organları etkilediği bilinmektedir. Göz tutulumu genellikle retina veya koroid vasküler bulguları ile değerlendirilse de, vitreus sıvısındaki olası değişikliklere sınırlı ilgi gösterilmiştir. Bu çalışma, difüzyon ağırlıklı manyetik rezonans görüntülemenin (DW-MRI), görünür difüzyon katsayısı (ADC) değerlerini ölçerek hipertansiyonla ilişkili vitreus sıvısındaki değişiklikleri tespit edip edemeyeceğini araştırmıştır.

Yöntem: Bu retrospektif kesitsel çalışmaya, orbital DW-MRG uygulanmış 100 hipertansiyon hastası ile hipertansiyon grubuyla yaş ve cinsiyet dağılımına göre frekans eşleştirmesi yapılmış 100 kontrol dahil edildi. Vitreus humor ADC değerleri, standartlaştırılmış ilgi bölgeleri (ROI) kullanılarak ADC haritaları üzerinden ölçüldü. Sağ, sol ve ortalama ADC değerleri gruplar arasında karşılaştırıldı. Ortalama ADC ile bağımsız olarak ilişkili faktörleri belirlemek amacıyla çok değişkenli doğrusal regresyon analizi kullanıldı. Örneklem içi ayırt edici performans, alıcı işletim karakteristiği (ROC) analizi kullanılarak araştırıldı. Gözlemci içi güvenilirlik, sınıf içi korelasyon katsayıları kullanılarak değerlendirildi.

Bulgular: Hipertansiyonu olan katılımcılarda ortalama vitreus ADC değeri kontrollere göre anlamlı derecede daha düşüktü ($2,18 \pm 0,20$ 'ye karşı $2,32 \pm 0,18 \times 10^{-3} \text{ mm}^2/\text{s}$; $p < 0,001$) ve fark orta-büyük düzeyde bir etki büyüklüğüne sahipti (Cohen's $d=0,72$). Çok değişkenli analizde hipertansiyon; yaş, cinsiyet ve diabetes mellitus için düzeltme yapıldıktan sonra da daha düşük ortalama ADC değeriyle bağımsız olarak ilişkiliydi ($B=-0,160$, %95 GA: $-0,210$ ila $-0,110$; standartlaştırılmış $\beta=-0,42$; $p < 0,001$). Ortalama ADC, değerlendirilen ölçütler arasında en yüksek örneklem içi ayırt edici performansı gösterdi (AUC= $0,83$, %95 GA: $0,77-0,89$); veriden türetilen $\leq 2,25 \times 10^{-3} \text{ mm}^2/\text{s}$ eşik değerinde duyarlılık %78,0 ve özgüllük %75,0 idi. Yaş ile ortalama ADC arasında ters yönlü korelasyon saptandı ($r=-0,34$; $p < 0,001$). Ortalama ADC ölçümlerinin gözlemci içi tekrarlanabilirliği mükemmeldi (ICC= $0,96$, %95 GA: $0,94-0,97$).

Sonuç: Hipertansiyonu olan hastalarda vitreus ADC değerleri kontrollere göre daha düşüktü; bu bulgu, vitreus mikroyapısındaki hafif farklılıkları yansıtır olabilir. Ortalama ADC, hipertansif katılımcılar ile kontroller arasında örneklem içi ayırt edici performans göstermiş olsa da bu keşifsel bulgular, vitreus ADC ölçümünün klinik bir tanı testi olduğunu ortaya koymamaktadır. Bu bulguların klinik önemini açıklığa kavuşturmak için kapsamlı oftalmolojik değerlendirmeleri ve dış doğrulamayı içeren prospektif, çok merkezli çalışmalara ihtiyaç vardır.

Anahtar Sözcükler: Hipertansiyon, difüzyon ağırlıklı MRG, görünür difüzyon katsayısı, vitreus humor, oküler mikroyapı, biyobelirteçler.

Introduction

Hypertension remains one of the leading chronic disorders worldwide and continues to be a major contributor to cardiovascular morbidity and mortality. Long-standing elevation of blood pressure has been associated with progressive microvascular injury involving several organs, particularly the brain, kidneys, heart, and ocular tissues¹⁻⁴. Ocular manifestations are considered especially important because the eye is highly vulnerable to disturbances in microcirculation. For this reason, hypertensive ocular involvement has mainly been investigated through retinal and choroidal vascular abnormalities, which are commonly described under the term hypertensive retinopathy⁵⁻⁷.

Although the vascular effects of hypertension on the eye have been widely investigated, considerably less attention has been paid to avascular structures, including the vitreous humor. The vitreous body consists largely of water, collagen fibers, and hyaluronic acid within a gel-like extracellular framework, contributing to both ocular integrity and biochemical balance⁸⁻¹⁰. Even in the absence of direct vascularization, the vitreous environment may still be affected by adjacent ocular tissues as well as systemic physiological alterations. Therefore, subtle systemic alterations—particularly those involving microvascular dysfunction and fluid homeostasis—may indirectly affect its microstructural properties^{11,12}.

Diffusion-weighted magnetic resonance imaging (DW-MRI) has emerged as a powerful, non-invasive imaging modality capable of evaluating tissue microstructure through quantitative measurement of the apparent diffusion coefficient (ADC). ADC values reflect the mobility of water molecules within tissues and are sensitive to changes in cellular integrity, extracellular space composition, and microvascular perfusion^{13,14}. Over the past decade, diffusion MRI has gained increasing attention in the evaluation of orbital and ocular tissues because of its ability to provide quantitative information beyond that obtained with routine imaging methods¹⁵⁻¹⁸. By assessing water molecule mobility within tissues, this technique offers insight into subtle microstructural alterations that may not be visible on conventional examinations.

Several earlier studies have noted that vitreous ADC measurements may vary under both physiological circumstances and disease-related conditions, especially in elderly individuals and in patients with diabetic retinopathy^{11,12,19}. These studies showed that the vitreous body undergoes measurable diffusion-related changes that may reflect systemic biological influences or underlying local tissue remodeling. In contrast, the relationship between hypertension and vitreous diffusion behavior has not been comprehensively studied, and the current evidence on this subject remains relatively limited.

Chronic hypertension has been associated with abnormalities in endothelial function, disruption of vascular autoregulatory mechanisms, and increased capillary permeability. These vascular and microenvironmental changes may alter extracellular fluid regulation and tissue organization, which could subsequently influence diffusion properties even within avascular structures such as the vitreous humor²⁰⁻²². In this context, quantitative assessment of vitreous ADC values may offer an alternative approach for identifying subtle ocular involvement related to systemic hypertension.

Within this framework, diffusion MRI may provide additional insight into ocular microstructural alterations that cannot be readily identified by standard ophthalmological assessment. Detecting these subtle changes could improve understanding of the systemic effects of hypertension and may also contribute to the identification of early imaging markers of hypertensive target-organ involvement.

The present study retrospectively examined vitreous humor ADC values in patients with hypertension and compared them with those obtained from normotensive individuals using diffusion MRI. We proposed that hypertension would be associated with

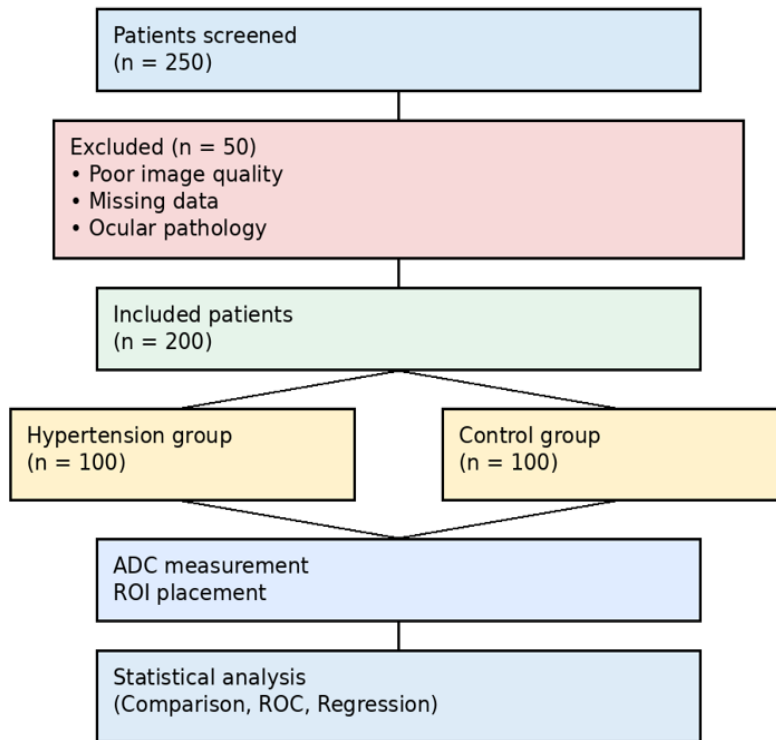
measurable alterations in vitreous diffusion characteristics. Through quantitative evaluation of vitreous ADC measurements, this study aimed to further investigate whether systemic hypertension influences avascular ocular tissues and to broaden current knowledge regarding hypertensive end-organ injury.

Material and Methods

Study Design and Population

This retrospective cross-sectional study was designed to investigate whether hypertension is associated with alterations in vitreous humor diffusion properties assessed by DW-MRI.

Patients who underwent brain and orbital magnetic resonance imaging, including diffusion-weighted imaging, for clinical indications between January 2020 and April 2026 were retrospectively identified from the hospital Picture Archiving and Communication System (PACS) and electronic medical records. Hypertension status was determined from a physician-documented diagnosis recorded in the electronic medical records before the index MRI examination. Controls were operationally defined as individuals without a documented history of hypertension in the available clinical records. Controls were frequency matched, rather than individually matched, to the hypertension group according to the overall age and sex distributions, with an intended group ratio of 1:1; therefore, no fixed patient-to-patient matching pairs were created. Because standardized repeated office or ambulatory blood pressure measurements were not available for all participants, hypertension status was not independently reclassified according to blood pressure measurements obtained at the time of MRI. Eligible participants were required to be 18 years of age or older, to have DW-MRI data including ADC maps, and to possess sufficient image quality to allow reliable vitreous ADC measurements. Participants were required to have complete demographic and clinical records as well as MRI examinations without structural abnormalities that could interfere with ocular assessment. Subjects were excluded in cases of inadequate image quality caused by motion or technical artifacts, previous ocular surgery or trauma, or the presence of ocular disorders such as vitreous hemorrhage, retinal detachment, or intraocular masses. Individuals with diabetic retinopathy, active inflammatory eye disorders, or concomitant neurological and systemic conditions that might influence orbital diffusion findings were not included in the study population. In addition, pregnant or lactating women and subjects with incomplete demographic or clinical records were excluded from further evaluation (Figure 1).

Figure 1. Flowchart of the study.

MRI Acquisition, ADC Measurement, and Data Collection

MRI examinations were performed using a 1.5-T magnetic resonance system (MAGNETOM Aera, Siemens Healthineers, Erlangen, Germany) with a 20-channel head/neck coil. Axial diffusion-weighted images were acquired using a single-shot echo-planar imaging sequence with b-values of 0 and 1000 s/mm². The acquisition parameters were as follows: repetition time/echo time, 3469/92 ms; section thickness, 5 mm; interslice gap, 1 mm; field of view, 230 × 230 mm; acquisition matrix, 128 × 128; number of excitations, 1; and acquired voxel size, 1.8 × 1.8 × 5.0 mm³. ADC maps were automatically generated on the workstation using a monoexponential signal-decay model.

ADC evaluation of the vitreous humor was carried out through the PACS-based analysis platform. Circular regions of interest with similar dimensions were manually placed in the central vitreous cavity while excluding adjacent ocular structures, including the retina, lens, and optic nerve head. Separate measurements were obtained for each eye, after which a mean ADC value was derived for every subject. Image interpretation and measurements were completed by a radiologist with experience in orbital imaging (D.U.Ç.), who had no access to the clinical characteristics of the participants during the evaluation process.

To assess intra-observer reproducibility, the same radiologist repeated ROI placement and ADC measurements in a randomly selected subset of 100 participants (50 patients

with hypertension and 50 controls) after a 4-week interval. During the second assessment, the radiologist was blinded to the initial measurements. Intra-observer agreement was assessed using a two-way mixed-effects, absolute-agreement, single-measure intraclass correlation coefficient model [ICC(A,1)].

For each participant included in the analysis, information regarding demographic characteristics, clinical findings, and imaging measurements was collected. Age and gender were recorded as demographic variables. Clinical data included the presence of hypertension, documented duration of disease where available, and concomitant conditions, including diabetes mellitus. Imaging evaluation included ADC measurements obtained from the right and left vitreous bodies and calculated average vitreous ADC values ($\times 10^{-3}$ mm²/s). Prior to the analysis phase, all records were anonymized to ensure patient privacy and confidentiality.

Ethical Statement

The study protocol was reviewed and approved by the Gaziantep City Hospital Non-Interventional Clinical Research Ethics Committee (Approval No: 445/2026; Date: March 6, 2026). The study was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective design and the use of anonymized patient data, the requirement for written informed consent was waived by the ethics committee.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA) and R version 4.3.0 (R Foundation for Statistical Computing, Vienna, Austria). The distribution of continuous variables was evaluated using the Shapiro–Wilk test together with histogram and Q–Q plot inspection. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation and compared using Student’s independent-samples t-test. Non-normally distributed variables were expressed as median and interquartile range and compared using the Mann–Whitney U test. Categorical variables were presented as frequencies and percentages and compared using the chi-square test or Fisher’s exact test, as appropriate. Effect sizes for between-group differences in continuous variables were reported using Cohen’s *d*.

Associations between age and vitreous ADC measurements were evaluated using Pearson’s or Spearman’s correlation analysis, depending on the distribution of the variables. Hypertension duration was summarized descriptively but was not included in the correlation analyses because sufficiently complete and standardized duration data were not available for all patients. Multivariable linear regression analysis was performed with mean vitreous ADC as the dependent variable and hypertension status, age, sex, and diabetes mellitus as the prespecified independent variables. Linearity was assessed using partial residual plots, normality of residuals using Q–Q plots, and homoscedasticity using plots of standardized residuals against predicted values. Independence of residuals was evaluated using the Durbin–Watson statistic.

Multicollinearity was assessed using variance inflation factors, with a value >5 considered indicative of relevant multicollinearity. Standardized residuals, leverage values, and Cook's distance were examined to identify potentially influential observations.

Receiver operating characteristic (ROC) curves were constructed for the right, left, and mean vitreous ADC values, ADC asymmetry, and ADC/age ratio, using clinically documented hypertension status as the binary reference variable. ROC curves were generated by plotting sensitivity against $1 - \text{specificity}$ across all possible thresholds. The area under the curve (AUC) and its 95% confidence interval were calculated for each parameter. The optimal cut-off value was selected by maximizing the Youden index ($\text{sensitivity} + \text{specificity} - 1$), and the corresponding sensitivity and specificity were reported. Pairwise comparisons between correlated AUCs were performed using the two-sided DeLong test.

The extent of missing data was assessed for each study variable. Primary group comparisons, ROC analyses, and multivariable regression analyses were performed using complete cases, and no imputation was applied. Because eligibility required complete demographic, hypertension-status, diabetes-status, and ADC data, no observations were missing for the variables included in the primary analyses. Hypertension duration was analyzed descriptively using the available records only. Intra-observer agreement was evaluated using a two-way mixed-effects, absolute-agreement, single-measure intraclass correlation coefficient model [ICC(A,1)]. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

Results

The study included 100 hypertensive patients and 100 control subjects. The mean age was 58.4 ± 10.2 years in the hypertension group and 57.9 ± 9.8 years in the control group ($p = 0.72$). The distribution of sex was similar between the groups (male/female: 54/46 vs. 52/48, $p = 0.76$). The prevalence of diabetes mellitus was significantly higher in the hypertension group compared to the control group (32.0% vs. 12.0%, $p < 0.001$). The mean duration of hypertension in the patient group was 8.6 ± 5.1 years (Table 1).

Table 1. Demographic and Clinical Characteristics of the Study Population.

Variable	Hypertension (n = 100)	Control (n = 100)	p-value
Age (years)	58.4 ± 10.2	57.9 ± 9.8	0.72
Gender (Male/Female)	54 / 46	52 / 48	0.76
Diabetes mellitus, n (%)	32 (32.0%)	12 (12.0%)	<0.001
Hypertension duration (years) (n=100)	8.6 ± 5.1	—	—

Comparison of vitreous humor ADC values between groups are presented in table 2. The hypertensive group demonstrated significantly lower vitreous humor ADC values compared to the control group. Both right and left vitreous ADC measurements were significantly reduced in hypertensive patients ($p < 0.001$ for both). Mean ADC values were significantly lower in the hypertension group (2.18 ± 0.20 vs. $2.32 \pm 0.18 \times 10^{-3} \text{ mm}^2/\text{s}$, $p < 0.001$). Right-left ADC differences and ADC asymmetry were significantly higher in hypertensive patients, indicating increased heterogeneity in vitreous diffusion properties. The ADC/age ratio was also significantly lower in the hypertensive group ($p = 0.018$). Mean ADC demonstrated a moderate-to-large effect size (Cohen's $d = 0.72$) (Table 2).

Table 2. Comparison of Vitreous Humor ADC Values Between Groups.

Parameter	Hypertension (n = 100)	Control (n = 100)	Cohen's d	p-value
Right Vitreous ADC ($\times 10^{-3} \text{ mm}^2/\text{s}$)	2.18 ± 0.21	2.32 ± 0.19	0.69	<0.001
Left Vitreous ADC ($\times 10^{-3} \text{ mm}^2/\text{s}$)	2.17 ± 0.22	2.31 ± 0.20	0.66	<0.001
Mean ADC ($\times 10^{-3} \text{ mm}^2/\text{s}$)	2.18 ± 0.20	2.32 ± 0.18	0.72	<0.001
Right-Left ADC Difference	0.06 ± 0.04	0.04 ± 0.03	0.57	0.003
ADC Asymmetry (%)	2.7 ± 1.9	1.9 ± 1.4	0.48	0.002
ADC/Age Ratio	0.038 ± 0.011	0.041 ± 0.010	0.28	0.018

In the multivariable linear regression model, hypertension was independently associated with lower mean vitreous ADC values ($B = -0.160$, 95% CI: -0.210 to -0.110 ; standardized $\beta = -0.42$; $p < 0.001$). Increasing age was also negatively associated with mean ADC ($B = -0.0035$ per year, 95% CI: -0.0050 to -0.0020 ; standardized $\beta = -0.28$; $p < 0.001$). Diabetes mellitus was independently associated with lower mean ADC values ($B = -0.075$, 95% CI: -0.130 to -0.020 ; standardized $\beta = -0.19$; $p = 0.008$). Sex was not significantly associated with mean ADC ($B = 0.019$, 95% CI: -0.011 to 0.049 ; standardized $\beta = 0.06$; $p = 0.210$) (Table 3).

Table 3. Multivariable Linear Regression Analysis for Predicting ADC Values.

Variable	Unstandard. B	SE	Standardized β	95% CI for B	P-value
Hypertension (yes vs. no)	-0.160	0.026	-0.42	-0.210 to -0.110	<0.001
Age (per year)	-0.0035	0.0008	-0.28	-0.0050 to -0.0020	<0.001
Sex (male vs. female)	0.019	0.015	0.06	-0.011 to 0.049	0.210
Diabetes mellitus (yes vs. no)	-0.075	0.028	-0.19	-0.130 to -0.020	0.008

The dependent variable was mean vitreous ADC, expressed in $\times 10^{-3}$ mm²/s. B represents the unstandardized regression coefficient, whereas β represents the standardized regression coefficient. The 95% confidence intervals refer to the unstandardized B coefficients. SE, standard error; CI, confidence interval. Reference categories were absence of hypertension, female sex, and absence of diabetes mellitus.

Exploratory ROC analysis demonstrated that vitreous ADC measures could discriminate between participants with hypertension and controls within the study sample. Mean ADC showed the highest AUC (0.83, 95% CI: 0.77–0.89; $p < 0.001$), with a data-derived cut-off of $\leq 2.25 \times 10^{-3}$ mm²/s, corresponding to a sensitivity of 78.0% and specificity of 75.0%. Pairwise comparison using the DeLong test showed that the AUC for mean ADC was significantly higher than those for ADC asymmetry ($p = 0.004$) and the ADC/age ratio ($p = 0.009$), but did not differ significantly from the AUCs for right or left vitreous ADC ($p = 0.312$ and $p = 0.428$, respectively). Because the cut-off and performance estimates were derived and evaluated in the same retrospective case–control sample, these findings should be considered exploratory and should not be interpreted as evidence of clinical diagnostic utility (Table 4, Figure 2).

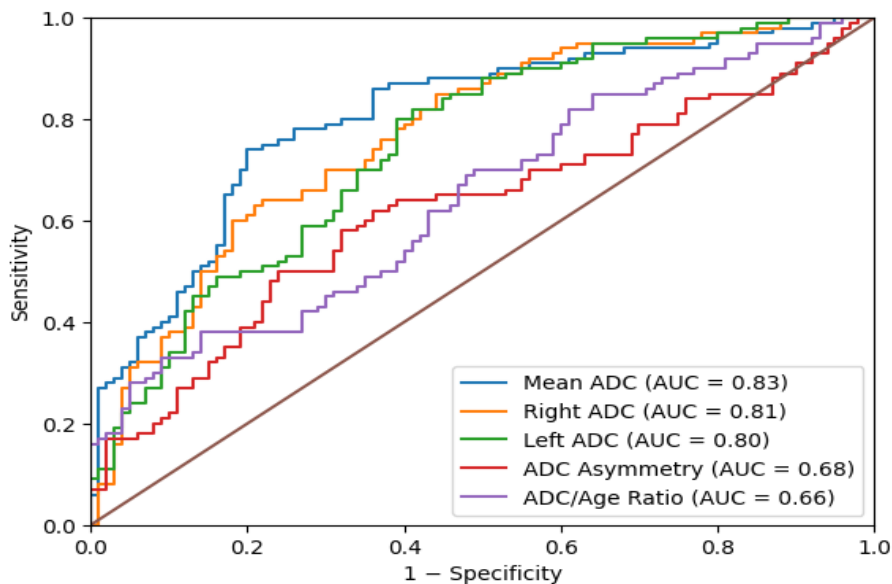
Table 4. Exploratory ROC Analysis of ADC Measures for Discriminating Between Participants with Hypertension and Controls.

Parameter	AUC	95% CI	Cut-off	Sensitivity (%)	Specificity (%)	p-value
Mean ADC ($\times 10^{-3}$ mm ² /s)	0.83	0.77–0.89	≤ 2.25	78.0	75.0	<0.001
Right Vitreous ADC	0.81	0.75–0.87	≤ 2.26	76.0	73.0	<0.001
Left Vitreous ADC	0.80	0.74–0.86	≤ 2.25	75.0	72.0	<0.001

ADC Asymmetry (%)	0.68	0.60–0.76	≥ 2.3	62.0	65.0	0.002
ADC/Age Ratio	0.66	0.58–0.74	≤ 0.039	60.0	63.0	0.005
Pairwise Comparison of AUCs (DeLong Test)						p-value
Mean ADC vs Right ADC						0.312
Mean ADC vs Left ADC						0.428
Mean ADC vs ADC Asymmetry						0.004
Mean ADC vs ADC/Age Ratio						0.009

Cut-off values were derived and evaluated in the same retrospective case–control sample and were not externally validated; therefore, they should not be interpreted as clinically validated diagnostic thresholds.

Figure 2. ROC curves comparing the diagnostic performance of vitreous humor ADC parameters for detecting hypertension.



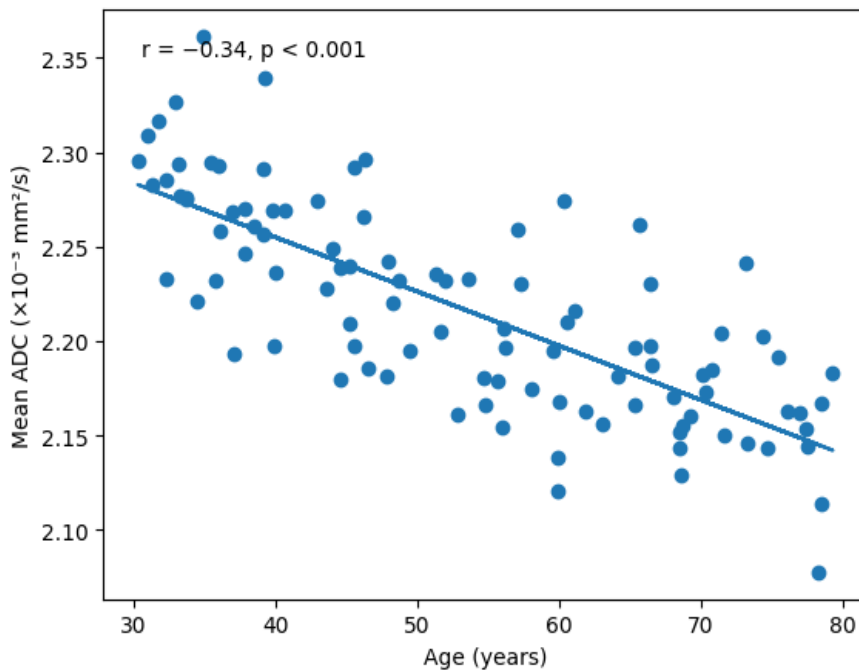
Intra-observer reliability analysis based on repeat measurements obtained from 100 randomly selected participants after a 4-week interval demonstrated excellent agreement for vitreous ADC measurements. The intraclass correlation coefficients (ICC) were 0.94 (95% CI: 0.91–0.96) for right vitreous ADC, 0.93 (95% CI: 0.90–0.95) for left vitreous ADC, and 0.96 (95% CI: 0.94–0.97) for mean ADC values (Table 5).

Table 5. Intra-observer reliability of ADC measurements.

Parameter	ICC	95% CI
Right Vitreous ADC	0.94	0.91–0.96
Left Vitreous ADC	0.93	0.90–0.95
Mean ADC	0.96	0.94–0.97

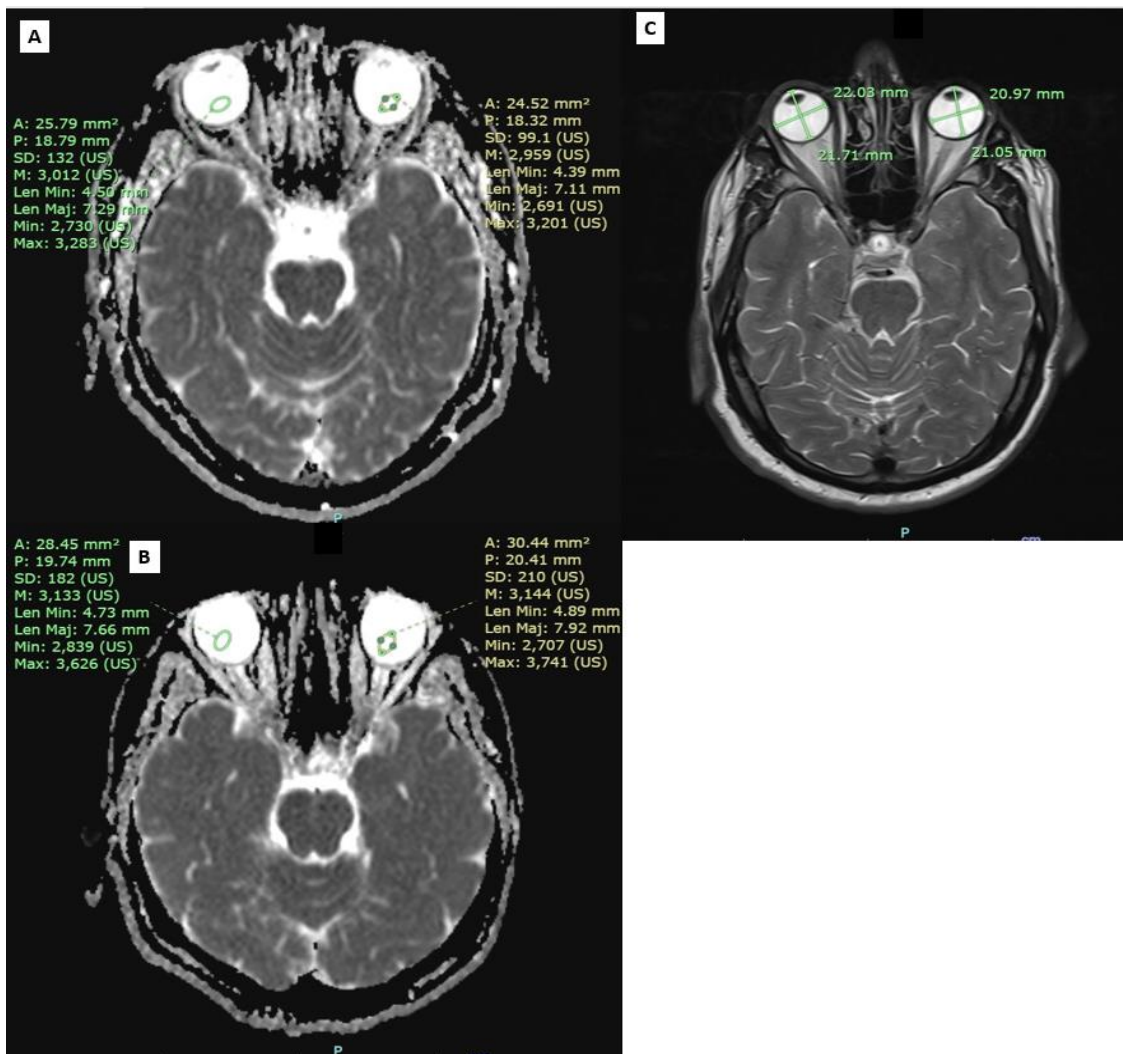
ICC estimates were calculated using a two-way mixed-effects, absolute-agreement, single-measure model [ICC(A,1)] based on repeat measurements obtained from 100 participants after a 4-week interval. ICC, intraclass correlation coefficient; CI, confidence interval.

Pearson correlation analysis demonstrated a significant inverse association between age and mean vitreous ADC ($r=-0.34$, $p<0.001$), indicating that vitreous ADC values decreased with increasing age. Similar inverse correlations were observed for right and left vitreous ADC values ($r=-0.31$ and $r=-0.29$, respectively; both $p<0.001$). In contrast, ADC asymmetry was weakly positively correlated with age ($r=0.18$, $p=0.021$), whereas the ADC/age ratio showed a strong inverse correlation with age ($r=-0.52$, $p<0.001$) (Figure 3).

Figure 3. Correlation analysis between age and mean vitreous ADC values.

ROI-based ADC assessments demonstrated consistent placement of the regions of interest within the central vitreous cavity. In the representative images, ROI areas ranged from 24.5 to 30.4 mm², and the within-ROI standard deviations ranged from 0.10 to 0.21 $\times 10^{-3}$ mm²/s. The representative ROI-derived ADC values were 2.17×10^{-3} mm²/s in a participant with hypertension and 2.33×10^{-3} mm²/s in a control participant, consistent with the corresponding group distributions (Figure 4).

Figure 4. Representative orbital diffusion MRI images illustrating vitreous ADC measurement. (A) ADC map from a participant with hypertension showing a manually placed circular ROI within the central vitreous cavity, with an ADC value of 2.17×10^{-3} mm²/s. (B) ADC map from a control participant showing central vitreous ROI placement, with an ADC value of 2.33×10^{-3} mm²/s. (C) Corresponding T2-weighted orbital image used as an anatomical reference for ROI placement. The retina, lens, optic disc, and ocular wall were excluded from the ROIs. ADC, apparent diffusion coefficient; ROI, region of interest.



Discussion

In this study, vitreous ADC values were lower in participants with hypertension than in controls, suggesting that systemic hypertension may be associated with measurable differences in the microstructural properties of avascular ocular tissues. Among the evaluated measures, mean vitreous ADC showed the largest between-group effect and the highest within-sample AUC. These observations suggest that hypertension-related alterations in microvascular regulation and tissue fluid homeostasis may influence the vitreous environment in addition to conventionally recognized vascular ocular structures. However, the present findings are exploratory and do not establish a causal relationship or clinical diagnostic utility.

Earlier investigations examining ocular involvement in hypertension have largely concentrated on vascular structures, particularly the retinal and choroidal circulation. Del Pinto et al. and Dziedziak et al. emphasized that hypertensive retinopathy mirrors systemic microvascular injury and may provide clinically relevant information regarding cardiovascular status^{4,5}. Unlike those reports, which mainly addressed vascular alterations, our findings suggest that hypertension-related changes may also be detectable within avascular ocular compartments such as the vitreous humor, where measurable microstructural differences were observed.

Reduced vitreous ADC values observed in hypertensive individuals may be related to several mechanisms associated with chronic vascular injury, including endothelial impairment, disturbances in capillary permeability, and alterations in extracellular fluid regulation. Previous studies by Ambrosino et al. and Gallo et al. reported that hypertension can disrupt endothelial integrity and modify tissue fluid dynamics on a systemic level^{20,21}. Even though the vitreous humor itself is avascular, its biochemical and structural environment remains closely connected to adjacent retinal and choroidal tissues. Consequently, hypertension-related microvascular abnormalities may indirectly influence diffusion behavior within the vitreous body.

Diffusion-weighted MRI is considered a sensitive imaging technique for identifying subtle alterations in tissue microstructure²³. Fokkinga et al. demonstrated that diffusion MRI may function as an indirect indicator of tissue integrity across different organ systems²⁴. Le Bihan et al. showed that ADC measurements are closely linked to water molecule motion and reflect characteristics of tissue organization and extracellular matrix composition²⁵. Gupta et al. and Tanenbaum et al. reported the usefulness of diffusion MRI in the evaluation of orbital and ocular tissues, particularly for detecting changes that may not be apparent on routine imaging^{26,27}. Taken together, these investigations support the rationale for using vitreous ADC measurements to investigate microstructural alterations in the eye.

Our findings are in line with earlier reports demonstrating that vitreous ADC measurements may change in different ocular and systemic conditions. Furthermore, Unlu et al. reported abnormal vitreous ADC values in diabetic retinopathy, suggesting that systemic metabolic disturbances may affect vitreous diffusion characteristics¹¹.

Ankamah et al. showed that aging-related vitreous degeneration, characterized by collagen aggregation and progressive liquefaction, can modify water diffusion within the vitreous body²⁸. Meral et al. also reported that ADC values tend to decline with advancing age, reflecting gradual microstructural alterations in the vitreous matrix¹². Consistent with these studies, our findings suggest that hypertension may also be associated with measurable differences in vitreous microstructure.

In the current study, increasing age was associated with lower vitreous ADC values, demonstrating a significant negative correlation. This observation is compatible with previous studies describing age-related degenerative changes within the vitreous body^{12,27,28}. In addition, the marked inverse relationship identified for the ADC/age ratio suggests that both aging and systemic vascular alterations may jointly influence vitreous microstructure. Taken together, these results support the view that vitreous diffusion characteristics may be affected by a combination of physiological aging processes and hypertension-related pathological changes.

Multivariable regression analysis demonstrated that hypertension remained independently associated with lower vitreous ADC measurements after adjustment for potential confounders including age, sex, and diabetes mellitus. This finding is noteworthy because diabetes mellitus was more common among hypertensive participants and could potentially influence diffusion characteristics. Despite this imbalance, hypertension continued to show an independent relationship with vitreous ADC reduction, suggesting a possible direct effect of hypertensive vascular pathology on vitreous microstructure.

Previous studies have reported comparable microstructural alterations in other organs affected by chronic hypertension. Diffusion MRI studies involving the brain and kidneys have demonstrated that hypertension may produce measurable microstructural injury beyond the vascular system itself^{3,15}. Furthermore, Liu et al. reported that hypertension-related cerebral small vessel disease is associated with detectable diffusion MRI abnormalities in brain tissue²⁹. These observations further support the concept that hypertensive damage may have widespread systemic effects involving multiple tissue compartments.

From a diagnostic perspective, in exploratory within-sample ROC analysis, mean vitreous ADC showed discrimination between participants with hypertension and controls. DeLong comparisons indicated that mean ADC had a higher AUC than ADC asymmetry and the ADC/age ratio, whereas its performance was comparable to that of right and left ADC measurements. However, the cut-off value was selected and evaluated in the same retrospective case-control sample, which may result in optimistic estimates of discrimination. Therefore, these results do not establish vitreous ADC as a diagnostic test for hypertension, and the reported threshold should not be used for clinical decision-making without prospective external validation.

The high reproducibility of ADC measurements represents an important strength of this study. The excellent intra-observer agreement indicates that ROI-based vitreous ADC

assessment is a reliable and feasible method. Previous diffusion MRI studies in oncology and organ imaging have similarly demonstrated that ADC values can serve as reproducible quantitative biomarkers¹⁶⁻¹⁸.

Compared with previously published studies, the present study provides a novel perspective by focusing on the microstructural properties of the vitreous humor in the context of systemic hypertension. Prior research has largely concentrated on vascular components of ocular involvement, particularly retinal and choroidal changes associated with hypertensive retinopathy^{4,5}. In contrast, studies investigating diffusion characteristics of the vitreous humor have primarily been limited to aging and metabolic conditions such as diabetic retinopathy^{11,12}. Unlike these studies, our work specifically evaluates the impact of hypertension on an avascular ocular structure using diffusion MRI. Furthermore, we extend previous findings by demonstrating not only significant group differences but also independent associations through multivariable regression analysis and clinically relevant diagnostic performance via ROC analysis. To the best of our knowledge, this is one of the first studies to systematically investigate vitreous ADC alterations in hypertension, thereby highlighting a previously underexplored pathway of hypertensive end-organ effects.

This study has some limitations. First, its retrospective design may introduce selection bias. Second, although major ocular pathologies were excluded, subclinical changes could not be entirely ruled out. Third, the imbalance in diabetes prevalence between groups may have influenced the findings, although this was addressed through multivariable adjustment. Finally, the single-center design may limit generalizability.

Conclusion and Recommendations

In conclusion, participants with hypertension had lower vitreous ADC values than controls, suggesting measurable differences in vitreous microstructure. Mean vitreous ADC showed the strongest association with hypertension and the highest within-sample discrimination among the evaluated imaging measures. However, because of the retrospective case–control design, these findings do not establish causality or support the use of vitreous ADC as a clinical diagnostic test. Prospective multicenter studies incorporating standardized blood pressure assessment, detailed antihypertensive treatment data, comprehensive ophthalmological evaluation, and external validation are needed to confirm these findings and clarify their clinical relevance.

REFERENCES

1. Durante A, Mazzapicchi A, Baiardo Redaelli M. Systemic and Cardiac Microvascular Dysfunction in Hypertension. *International Journal of Molecular Sciences*. 2024;25:13294-9. doi:10.3390/ijms252413294.

2. Kućmierz J, Frąk W, Młynarska E, Franczyk B, Rysz J. Molecular Interactions of Arterial Hypertension in Its Target Organs. *International Journal of Molecular Sciences*. 2021;22:9669-76. doi:10.3390/ijms22189669.
3. Sun D, Wang J, Shao W, et al. Pathogenesis and damage targets of hypertensive kidney injury. *Journal of Translational Internal Medicine*. 2020;8:205-9. doi:10.2478/jtim-2020-0033.
4. Del Pinto R, Mulè G, Vadalà M, et al. Arterial Hypertension and the Hidden Disease of the Eye: Diagnostic Tools and Therapeutic Strategies. *Nutrients*. 2022;14:2200-9. doi:10.3390/nu14112200.
5. Dziedziak J, Zaleska-Żmijewska A, Szaflik JP, Cudnoch-Jędrzejewska A. Impact of Arterial Hypertension on the Eye: A Review of the Pathogenesis, Diagnostic Methods, and Treatment of Hypertensive Retinopathy. *Medical Science Monitor*. 2022;28:935135. doi:10.12659/msm.935135.
6. Singh RB, Saini C, Shergill S, Agarwal A. Window to the circulatory system: Ocular manifestations of cardiovascular diseases. *European Journal of Ophthalmology*. 2020;30:1207-19. doi:10.1177/1120672120914232.
7. Sun C, Ladores C, Hong J, et al. Systemic hypertension associated retinal microvascular changes can be detected with optical coherence tomography angiography. *Scientific Reports*. 2020;10:1-10. doi:10.1038/s41598-020-66736-w.
8. Zhang R, Li B, Li H, Asiedu K. Extracellular-Matrix Mechanics Regulate the Ocular Physiological and Pathological Activities. *Journal of Ophthalmology*. 2023;2023:1-11. doi:10.1155/2023/7626920.
9. Mishra D, Gade S, Glover K, Sheshala R, Singh TRR. Vitreous Humor: Composition, Characteristics and Implication on Intravitreal Drug Delivery. *Current Eye Research*. 2022;48:208-18. doi:10.1080/02713683.2022.2119254.
10. Boneva S, Haritoglou C, Schultheiss M, Binder S, Sebag J. Die Rolle des Glaskörpers in der Pathogenese der exsudativen altersabhängigen Makuladegeneration. *Die Ophthalmologie*. 2023;120:992-8. doi:10.1007/s00347-023-01934-1.
11. Unlu S, Ilgar M. Diffusion MRI Evaluation of Vitreous Humor Changes in Diabetic Retinopathy Patients. *Medical Records*. 2022;4:187-90. doi:10.37990/medr.1054427.
12. Meral İ, Bilgili Y. Diffusion Changes in the Vitreous Humor of the Eye during Aging. *American Journal of Neuroradiology*. 2011;32:1563-6. doi:10.3174/ajnr.A2543.

13. Pacinella G, Ciaccio AM, Tuttolomondo A. Endothelial Dysfunction and Chronic Inflammation: The Cornerstones of Vascular Alterations in Age-Related Diseases. *International Journal of Molecular Sciences*. 2022;23:15722. doi:10.3390/ijms232415722.
14. Sheikh AM, Yano S, Tabassum S, Nagai A. The Role of the Vascular System in Degenerative Diseases: Mechanisms and Implications. *International Journal of Molecular Sciences*. 2024;25:2169-77. doi:10.3390/ijms25042169.
15. Mohamed Osman NM, Abdel Kader M, Aziz Nasr TAEL, Sharawy MA, Keryakos HKH. The Role of Diffusion-Weighted MRI and Apparent Diffusion Coefficient in Assessment of Diabetic Kidney Disease: Preliminary Experience Study. *International Journal of Nephrology and Renovascular Disease*. 2021;Volume 14:1-10. doi:10.2147/ijnrd.S254022.
16. Fliedner FP, Engel TB, El-Ali HH, Hansen AE, Kjaer A. Diffusion weighted magnetic resonance imaging (DW-MRI) as a non-invasive, tissue cellularity marker to monitor cancer treatment response. *BMC Cancer*. 2020;20:1-9. doi:10.1186/s12885-020-6617-x.
17. Balaha HM, Ayyad SM, Alksas A, et al. Precise Prostate Cancer Assessment Using IVIM-Based Parametric Estimation of Blood Diffusion from DW-MRI. *Bioengineering*. 2024;11:629-36. doi:10.3390/bioengineering11060629.
18. Raju J, Shyna A, John A, Pillai MJ. Transforming Medical Imaging with IVIM MR Imaging: A Comprehensive Review of Advances and Challenges in Perfusion and Diffusion Analysis. *Applied Magnetic Resonance*. 2025;56:803-43. doi:10.1007/s00723-025-01758-z.
19. Hwang M, Shin SS, Thimm MA, et al. Apparent Diffusion Coefficient (ADC) of the vitreous humor and Susceptibility Weighted Imaging (SWI) of the retina in abused children with retinal hemorrhages. *Clinical Imaging*. 2017;44:38-41. doi:10.1016/j.clinimag.2017.03.017.
20. Gallo G, Volpe M, Savoia C. Endothelial Dysfunction in Hypertension: Current Concepts and Clinical Implications. *Frontiers in Medicine*. 2022;8:798958. doi:10.3389/fmed.2021.798958.
21. Ambrosino P, Bachetti T, D'Anna SE, et al. Mechanisms and Clinical Implications of Endothelial Dysfunction in Arterial Hypertension. *Journal of Cardiovascular Development and Disease*. 2022;9:136- 42. doi:10.3390/jcdd9050136.
22. Humphrey JD. Mechanisms of Vascular Remodeling in Hypertension. *American Journal of Hypertension*. 2021;34:432-41. doi:10.1093/ajh/hpaa195.

- 23.** Le Bihan D, Iima M. Diffusion Magnetic Resonance Imaging: What Water Tells Us about Biological Tissues. *PLOS Biology*. 2015;13:e1002203. doi:10.1371/journal.pbio.1002203.
- 24.** Fokkinga E, Hernandez-Tamames JA, Ianus A, et al. Advanced Diffusion-Weighted MRI for Cancer Microstructure Assessment in Body Imaging, and Its Relationship With Histology. *Journal of Magnetic Resonance Imaging*. 2023;60:1278-304. doi:10.1002/jmri.29144.
- 25.** Bihan DL. Molecular diffusion, tissue microdynamics and microstructure. *NMR in Biomedicine*. 2005;8:375-86. doi:10.1002/nbm.1940080711.
- 26.** Tanenbaum RE, Lobo R, Kahana A, Wester ST. Advances in magnetic resonance imaging of orbital disease. *Canadian Journal of Ophthalmology*. 2022;57:217-27. doi:10.1016/j.jcjo.2021.04.025.
- 27.** Gupta L, Peterson EL, Williams C, et al. Diffusion-Weighted Imaging of the Orbit: A Case Series and Systematic Review. *Ophthalmic Plastic & Reconstructive Surgery*. 2023;39:407-18. doi:10.1097/iop.0000000000002325.
- 28.** Ankamah E, Sebag J, Ng E, Nolan JM. Vitreous Antioxidants, Degeneration, and Vitreo-Retinopathy: Exploring the Links. *Antioxidants*. 2019;9:7-15. doi:10.3390/antiox9010007.
- 29.** Liu N, Li N, Cao X, et al. More severe vascular remodeling in deep brain regions caused by hemodynamic differences is a potential mechanism of hypertensive cerebral small vessel disease. *Journal of Cerebral Blood Flow & Metabolism*. 2025;45:1593-605. doi:10.1177/0271678x251327919.

Prediction of Arsenic and Cadmium Intoxication Cases from *Lucilia Sericata* (Meigen, 1826) [Diptera: Calliphoridae] Larvae by ICP-MS*

Çağdaş ADIÖREN**, Selda MERCAN***, Murat YAYLA****, Sümeyye Zülal ŞİMŞEK DURAN*****,
Erdal POLAT*****

Abstract

Aim: This study aimed to develop and validate an Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)-based analytical method for detecting arsenic (As) and cadmium (Cd) in *Lucilia sericata* (Meigen, 1826) larvae fed on contaminated liver tissue and to evaluate the relationship between element concentrations in the feeding media and larvae.

Method: Chicken liver-based media spiked with different As and Cd concentrations were inoculated with approximately 100 *L. sericata* eggs and incubated for three days until the third instar stage. Larvae were digested with nitric acid and hydrogen peroxide, then analyzed by ICP-MS. Matrix-matched calibration curves were prepared from blank larvae, and method performance was assessed for linearity, limit of detection (LOD), limit of quantification (LOQ), recovery, and intra- and inter-day reproducibility.

Results: Matrix-matched calibration curves were linear in the range of 1–20 ng/mL for both elements. Recovery values ranged from 94.33% to 107.38% for As and from 97.98% to 108.16% for Cd. Intra-day relative standard deviation values were 3.46–8.51% for As and 2.22–10.36% for Cd. Larvae exposed to As and Cd showed shorter average lengths than the blank group. The correlation coefficients between element concentrations in the feeding media and larvae were 0.677 for As and 0.902 for Cd.

Conclusion: The developed ICP-MS method provided accurate and reproducible detection of As and Cd in *L. sericata* larvae. These findings suggest that larval elemental analysis may provide useful toxicological information in forensic investigations, particularly when conventional biological matrices are unavailable in suspected post-mortem poisoning cases.

Keywords: Forensic entomology, entomotoxicology, *Lucilia sericata*, ICP-MS, arsenic, cadmium.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 08.06.2026 **Kabul / Accepted:** 26.06.2026

DOI: <https://doi.org/10.38079/igusabder.1966394>

* This study was supported by the Scientific Research Projects Unit of Istanbul University-Cerrahpasa, Türkiye, under project number FYL-2020-3450.

** Lecturer, Istanbul Gelisim University, Vocational School of Health Services, Autopsy Assistantship, Istanbul, Türkiye. E-mail: cadioren@gelisim.edu.tr [ORCID https://orcid.org/0000-0003-1150-9884](https://orcid.org/0000-0003-1150-9884)

*** Prof., Istanbul University-Cerrahpasa, Institute of Forensic Sciences and Legal Medicine, Department of Science, Istanbul, Türkiye. E-mail: mercans@iuc.edu.tr [ORCID https://orcid.org/0000-0002-0431-6972](https://orcid.org/0000-0002-0431-6972)

**** MSc., Istanbul University-Cerrahpasa, Institute of Forensic Sciences and Legal Medicine, Department of Science, Istanbul, Türkiye. E-mail: murat.yayla@iuc.edu.tr [ORCID https://orcid.org/0000-0003-3683-945X](https://orcid.org/0000-0003-3683-945X)

***** Asst. Prof., PhD., Istanbul Yeni Yüzyıl University, Faculty of Medicine, Department of Forensic Medicine, Istanbul, Türkiye. E-mail: sumeyyezulalsimsek.duran@yeniuyuzyl.edu.tr; sumeyye.zulal@gmail.com [ORCID https://orcid.org/0000-0001-9060-6775](https://orcid.org/0000-0001-9060-6775)

***** Prof., Istanbul University-Cerrahpasa, Department of Basic Medical Sciences, Istanbul University-Cerrahpasa Faculty of Medicine, Istanbul, Türkiye. E-mail: erdalp@iuc.edu.tr [ORCID https://orcid.org/0000-0002-3944-6443](https://orcid.org/0000-0002-3944-6443)

ICP-MS ile *Lucilia Sericata* (Meigen, 1826) [Diptera: Calliphoridae] Larvalarından Arsenik ve Kadmiyum İntoksikasyon Olgularının Tahmini

Öz

Amaç: Bu çalışmada, kontamine karaciğer dokusu ile beslenen *Lucilia sericata* (Meigen, 1826) larvalarında arsenik (As) ve kadmiyum (Cd) tespiti için İndüktif Eşleşmiş Plazma-Kütle Spektrometrisi (ICP-MS) temelli bir analitik yöntemin geliştirilmesi ve valide edilmesi ile beslenme ortamı ve larvalardaki element konsantrasyonları arasındaki ilişkinin değerlendirilmesi amaçlanmıştır.

Yöntem: Farklı As ve Cd konsantrasyonları ile kontamine edilen tavuk karaciğeri temelli beslenme ortamlarına yaklaşık 100 *L. sericata* yumurtası inoküle edilmiş ve larvalar üçüncü evreye ulaşmaya kadar üç gün inkübe edilmiştir. Larvalar nitrik asit ve hidrojen peroksit ile parçalanarak ICP-MS ile analiz edilmiştir. Kör larvalardan matriks uyumlu kalibrasyon eğrileri hazırlanmış; yöntem performansı doğrusalılık, LOD, LOQ, geri kazanım ile gün içi ve günler arası yeniden üretilebilirlik açısından değerlendirilmiştir.

Bulgular: Matriks uyumlu kalibrasyon eğrileri her iki element için 1–20 ng/mL aralığında doğrusal bulunmuştur. Geri kazanım değerleri As için %94,33–107,38, Cd için %97,98–108,16 arasında belirlenmiştir. Gün içi bağıl standart sapma değerleri As için %3,46–8,51, Cd için %2,22–10,36 bulunmuştur. As ve Cd'ye maruz kalan larvaların ortalama uzunluklarının kör gruba göre daha düşük olduğu gözlenmiştir. Beslenme ortamı ve larvalardaki element konsantrasyonları arasındaki korelasyon katsayıları As için 0,677, Cd için 0,902 olarak hesaplanmıştır.

Sonuç: Geliştirilen ICP-MS yöntemi, *L. sericata* larvalarında As ve Cd'nin doğru ve tekrarlanabilir şekilde tespit edilmesini sağlamıştır. Bulgular, larval element analizinin özellikle geleneksel biyolojik matrikslerin bulunmadığı şüpheli post-mortem zehirlenme olgularında adli araştırmalara katkı sağlayabilecek toksikolojik bilgi sunabileceğini göstermektedir.

Anahtar Sözcükler: Adli entomoloji, entomotoksikoloji, *Lucilia sericata*, ICP-MS, arsenik, kadmiyum.

Introduction

Entomology, as a branch of zoology, encompasses the study of insects and all related circumstances. Forensic entomology, a specialized field within this discipline, examines the developmental stages of various insect and arthropod species found on decomposed cadavers, utilizing this information as auxiliary evidence in legal investigations^{1,2}. A corpse is often of vital importance in solving a crime; however, specifics such as the time and place of death, as well as substances the deceased might have been exposed to or forcibly administered before death, might not always provide clear information. Depending on the decay process and the available biological material, these questions may sometimes remain unanswered. Studying insects on decaying bodies allows forensic entomology to provide information that standard pathology, toxicology, and autopsy methods cannot facilitate the work of justice³.

Entomototoxicology, as a relatively new subdivision of forensic entomology, began in the late 1970s. Insects obtained from a decomposing body can provide valuable information for toxicological analyses through the organic and/or inorganic chemicals they contain⁴. Sohal and Lamb's early investigations established how environmental circumstances

influence the accumulation of metals in adult housefly tissues, including copper (Cu), iron (Fe), zinc (Zn), and calcium (Ca)^{5,6}. Phenobarbital was detected in 1980 for the first time in fly larvae during toxicological analysis⁷ while various drugs and toxins, including benzodiazepines, barbiturates, methamphetamine, bromazepam, cocaine, pesticides, mercury (Hg) etc., have been found in insect and larval tissues over the years⁸⁻¹⁴.

In 1982, Nuorteva and Nuorteva investigated Hg accumulation in fly larvae from the Calliphoridae family for the first time¹⁵. Additionally, Nolte et al. proved that larvae absorb chemicals from the bodies they feed on, making them a reliable source for toxicological analyses in 1992¹⁶. The ability of insects to detect drugs, narcotics, poisons, and metals such as Cu, Fe, Zn, and Ca resulting from environmental exposure has also been supported by research conducted by Amendt et al.¹⁷.

Gunshot residues (GSR) were successfully analyzed in larvae, and significantly higher concentrations of lead (Pb), barium (Ba), and antimony (Sb) were detected in larvae fed on shot meat¹⁸. Studies on GSR also revealed that the larvae's entire life cycle was prolonged by about 12 hours and their development rates were slowed down by the presence of GSR in their food¹⁹. Furthermore, experimental firearm studies have demonstrated that quantitative analysis of GSR elements (Sb, Ba, Pb) in *L. sericata* larvae feeding on bullet-perforated tissues, performed by ICP-MS, can be used to evaluate the relationship between shot number and elemental accumulation patterns²⁰.

Boulkenafet et al. examined the bioaccumulation of Hg and Cd in rabbit organs and *Chrysomya albiceps* (Wiedemann, 1819) larvae. This study evaluates the accumulation of these metals in rabbit organs following the application of Cd and cadmium chloride (CdCl₂), as well as in larvae that consume these organs. By using ICP-MS, significant amounts of Cd and Hg have been found to accumulate in rabbit organs and larvae. This implies the possible use of fly larvae as bioindicators of environmental pollutants in forensic entomology and has significant implications for the ecological effects of heavy metal exposure²¹.

Depending on the degree of decomposition and their feeding patterns, insects have been observed to inhabit cadavers in a certain order. *L. sericata* is one of the most studied species and is important to forensic entomologists since it appears early in the insect colonization of human remains^{22,23}. Post-Mortem Interval (PMI) can be estimated by studying the growth rate of this species' larvae and how long they remain on corpses. Important insights into recognizing GSR have also been gained from studies on *L. sericata*²⁴.

The accumulation of Cd and thallium (Tl) in different developmental stages of the fly *L. sericata*—a significant species for forensic science—was investigated in a study by Malejko et al. By determining the quantities of these metals in larvae, pupal shells, and adult flies, the study seeks to assess the utility of these metals as toxicological evidence in poisoning deaths. With the use of ICP-MS analysis, researchers were able to accurately and sensitively identify Cd and Tl accumulation in the fly *L. sericata* at different stages

of its life cycle. The outcome demonstrates that this species is a good choice for use as an indicator in toxicological studies²⁵.

In our research, we focused on As, a highly toxic metalloid known for both its acute and chronic effects. As famously referred to as the king of poisons and the poison of kings, it was a preferred and discreet poison among the elite during the Middle Ages and Renaissance^{26,27}. Early scientific studies on As primarily investigated its use as a remedy for fever, agues, and periodic headaches. However, its infamous reputation as a potent poison undoubtedly led to further toxicological research. Since the first paper published in 1786, there have been 32,346 reports and studies, most from the past few decades, focusing on the toxicity and carcinogenicity of this International Agency for Research on Cancer class I carcinogen²⁸. An element that is constantly found in the air, soil, water, plants, animals, and rocks is As. It is mostly released into the environment by forest fires, volcanic eruptions, weathering, and rock erosion. Surprisingly, As is an essential element in more than 200 distinct minerals. As a matter of fact, rocks and minerals contain 99 percent of As²⁹. It is typically present in rock-forming minerals such as silicates, phosphates, sulfides, and oxides, as well as sulfidic minerals like arsenopyrite, which are primarily found in anaerobic environments³⁰.

In order to diagnose As toxicity and clinical diseases associated with As, it is essential to determine the extent of As exposure. Environmental exposure assessment data is typically needed to confirm an exposure, even though biological monitoring data is also highly valued as an objective measurement. When As enters the body by the digestive or respiratory systems, it quickly transforms into over five distinct metabolites, which are then eliminated through the urine. Although there are benefits and drawbacks to each indicator, blood, urine, nails, and hair may all be signs of internal As exposure³¹.

The most reliable indicator of a recent exposure to elevated levels of As is blood. As levels, due to the unique properties of the blood matrix, blood measurements are more challenging to interpret than urine measures. Urine is known to be the best biomaterial for detecting As exposure since most As species are excreted in it and can be quantified there. Urine containing As may be a sign of exposure to As during the two to three days prior³¹. However, a variety of confounding factors, such as sex, age, individual variation, smoking, and dietary factors, make it difficult to examine the amounts of As in the urine^{32,33}. As enters the body through the respiratory system or gastrointestinal tract and then spreads widely in the body by mixing with the blood. It particularly accumulates more intensively in tissues rich in keratin, such as skin, hair, and nails, compared to bones and teeth. As ingested by the body is primarily metabolized in the liver and then excreted through the urine by the kidneys^{34,35}.

Cadmium (Cd), on the other hand, is among the metals with high toxicity levels for humans and animals. Cd has entered the environment as a pollutant due to the quick development of modern industries and technologies³⁶. Contaminated food, drink, and air absorb it heavily. High Cd content has been found in crustaceans, bivalve mollusks, oysters, cephalopods, and crabs. High concentrations of Cd have been found in oil seeds, cocoa beans, liver, kidney, and certain wild mushrooms, among other offal products³⁷.

Low-level Cd exposure harms the kidneys, liver, bones, and heart and causes vision and hearing loss³⁸.

Only a few studies have evaluated the overall amount of Cd in the human body. The field's pioneering work dates back to studies published in the late 1950s; Kjellström's 1979 summary is a great resource. Total body load and Cd turnover were previously measured in individuals who had either undergone acute intoxication or long-term chronic exposure to Cd. Thus, it was necessary to evaluate the amounts of Cd in a variety of substances, such as food, feces, tobacco smoke, and tissues, including the kidney, liver, muscle, blood, and pancreas³⁹⁻⁴¹. The most hazardous route of exposure to Cd metalloid is through ingestion of its dust or inhalation of its fumes. Similar to As, Cd is metabolized in the liver after exposure and then excreted from the body through the urine by the kidneys^{42,43}.

ICP-MS is an advanced analytical technique used for element analysis. This method is preferred for efficiently detecting, identifying, and quantitatively measuring trace elements across a broad spectrum of research fields, ranging from soil to environmental samples, and from biological to forensic materials, in industries such as food, materials science, chemistry, semiconductors, and nuclear^{44,45}.

In this research, using the larvae of the *L. sericata* species, an analysis method based on ICP-MS has been developed for the detection of As and Cd from the larvae. The primary goal of the study is to explore the effects of various concentrations of As and Cd on the growth and survival rates of the larvae and to elucidate the relationship between the amounts of As and Cd detected in the feeding media and the larvae.

Material and Methods

Chemicals and Equipment

In this research, all chemicals and reagents were of analytical grade. For sample dilution and digestion, a 65% (v/v) nitric acid solution was obtained from Merck Suprapur®. Indium (In) and gallium (Ga) (1000 mg mL⁻¹) as internal standards (ISs) were obtained from Absolute Standards, Inc., Hamden, CT, USA. A certified calibration solution mix (10 mg mL⁻¹) and Hg (1000 mg mL⁻¹) were purchased from High-Purity Standards, Charleston, SC. To obtain the argon plasma, argon gas (>99.999% purity, Habas, Turkey) was used for all measurements. A Thermo Fisher Scientific X Series-II ICP-MS system (Bremen, Germany, 2008) equipped with a CETAC, ASX 520 (Omaha, Nebraska, USA) autosampler was used. A microwave digestion was conducted with CEM Mars 5 (Matthews, NC, USA) equipped with temperature and pressure sensors. To obtain ultra-pure water (18.2 MΩ cm), a Millipore Direct-Q®3 UV purification system (Millipore, Molsheim, France) was used.

Validation Studies

Linearity and Calibration Curve

In this study, two separate calibration curves, including acid solution (2% HNO₃) and matrix-matched calibration solutions were established for the quantification of As and Cd. Calibration solutions prepared in 2% HNO₃ solution were in the range of 0,1-100 (0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100) ng/mL, while matrix-matched calibration solutions were in the range of 1-20 (1, 2, 5, 10, 20) ng/mL. Matrix-matched calibration points were generated by spiking As and Cd in ascending concentrations to the blank larvae samples. Each concentration point for both calibration studies was prepared three times. During the analysis process, IS concentration was set to 20 ng/mL for each sample.

Detection Limit and Quantification Limit

To calculate the detection limit (LOD) and quantification limit (LOQ) values, the analysis of 10 different blank calibration solutions was conducted to obtain their standard deviations (SD). Subsequently, values were determined by taking three times the SD for LOD and ten times for LOQ.

Recovery and Reproducibility

Reproducibility and recovery studies were conducted by spiking the blank larval matrix with both analytes at concentrations of 1, 2, 5, 10, and 20 ng/mL, the experiment was repeated 8 times for each sample. The average concentrations, SD, relative standard deviation (RSD%), and recovery (REC%) were calculated using Microsoft Excel. For the inter-day reproducibility test, three separate samples containing the same concentrations were prepared for re-analysis on another day. The *Student's t-test* was applied to compare intra-day and inter-day reproducibility, examining the statistical significance at a 95% confidence interval and a p-value of 0.05.

Preparation of Samples

One kilogram of fresh chicken liver was commercially obtained from a local retail market. The liver was cut into small pieces and homogenized using a blender until a uniform, near-liquid consistency was achieved, ensuring the absence of solid tissue fragments. A total of 1000 mL of distilled water was boiled. Subsequently, 40 g of agar-agar was added to the boiling distilled water and stirred rapidly. The liquefied chicken liver was then added to the water-agar mixture, and the entire mixture was further homogenized using a blender. The prepared media was transferred into 1 L glass bottles, which were sterilized in an autoclave at 121°C.

L. sericata eggs were counted under a microscope, with approximately 100 eggs selected for each sample. The eggs were then inoculated onto culture media (40 mL each) that

had been spiked with As and Cd at concentrations of 1, 2, 5, 10 and 20 ng/mL, along with blank feeding medium.

They were incubated for 3 days to allow growth. For the larval length assessment, five randomly selected larvae from each group were measured (n=5 larvae per group). Sample tubes containing 'third instar larvae' (Fig. 1) portioned into 200, 100, and 50 mg were added with 5 mL of 65% HNO₃ and 2 mL of hydrogen peroxide (H₂O₂) to accelerate the reaction and samples were digested in an oven at 95°C for one hour.

Figure 1. Representative image of third-instar *L. sericata* (Meigen, 1826) larvae obtained after three days of incubation on chicken liver-based feeding media.



Samples were diluted to 20 mL using 2% HNO₃ and mixed. A 1 mL aliquot of sample was transferred into a 15 mL sample tube and diluted to 10 mL with ultra-pure water for ICP-MS analysis.

Ethical Statement

The experimental model used in this study involved larvae of *L. sericata*, an invertebrate species. According to the guidelines of the Istanbul University-Cerrahpaşa Animal Experiments Local Ethics Committee, studies involving invertebrates do not require ethical approval. Chicken liver, also used as feeding media was commercially obtained from a local retail market, and no animals were sacrificed specifically for the purposes of this study.

Results

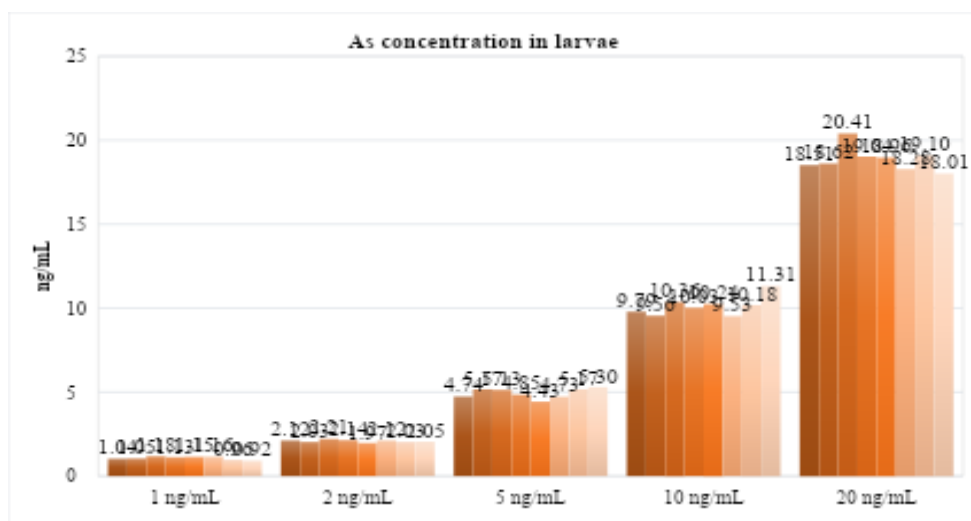
The calibration solutions prepared for As and Cd at increasing concentrations resulted in linear calibration curves following ICP-MS analysis. The method's linearity studies yielded two separate calibration curves. The first curve was acquired using a calibration solution that did not contain a matrix, whereas the second was obtained using the conventional addition procedure to the larval matrix. ICP-MS analysis of calibration solutions with increasing As and Cd contents yielded linear calibration curves, as shown in Table 1.

Table 1. Linearity, LOD, and LOQ Values for As and Cd in Different Calibration Media.

Elements	Calibration Media	Linear Range (ng/mL)	R ² *	LOD* (ng/mL)	LOQ* (ng/mL)
As	2% HNO ₃ * solution	0.1 – 100	>0.999	0.02	0.08
	Larvae matrix	1 – 20		0.059	0.132
Cd	2% HNO ₃ solution	0.1 – 100	>0.999	0.003	0.01
	Larvae matrix	1 – 20		0.027	0.067

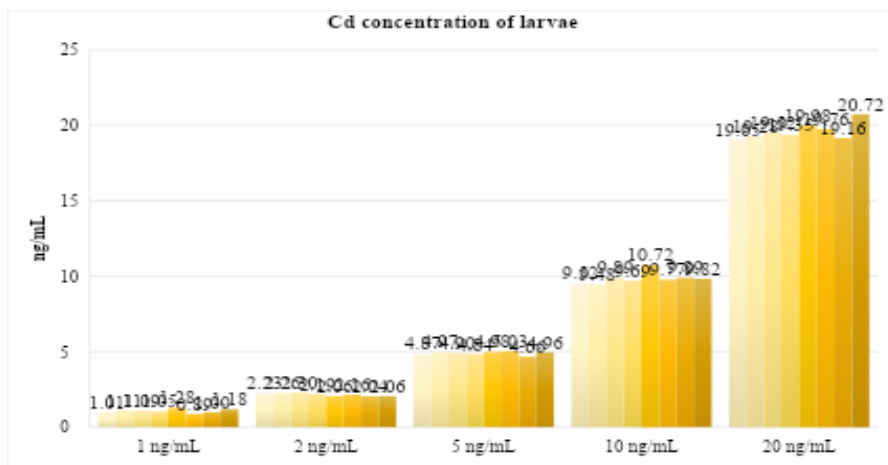
* HNO₃: Nitric acid; LOD: Limit of Detection; LOQ: Limit of Quantification; R²: Correlation coefficient

The results obtained from the repeatability analyses (n=8) for As at concentrations of 1, 2, 5, 10, and 20 ng/mL are shown in Fig. 2. REC% results of five spiked concentrations varied between 94.33% and 107.38%, while RSD% values were found in the range of 3.46- 8.51%.

Figure 2. Intra-day repeatability results for As analysis in the larval matrix at 1, 2, 5, 10, and 20 ng/mL (n=8).

The results and average values of the repeatability analyses (n=8) for Cd at concentrations of 1, 2, 5, 10, and 20 ng/mL are shown in Fig. 3. The results of five different REC% studies varied between 97.98% and 108.16%, while the RSD% values were found to be between 2.22% and 10.36%. SD values were determined to be ≤ 0.51 .

Figure 3. Intra-day repeatability results for Cd analysis in the larval matrix at 1, 2, 5, 10, and 20 ng/mL (n=8).

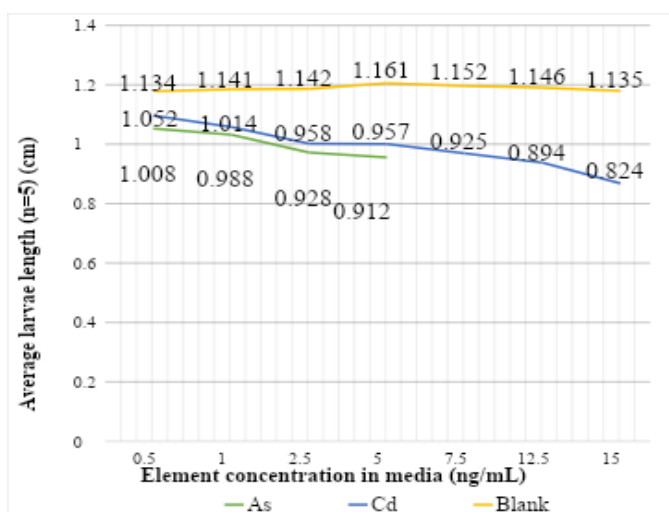


Inter-day repeatability analysis results and averages for different concentrations of As have been calculated. The results of five different recovery studies show REC%, RSD%, and SD values ranging, respectively, from 90.88% to 109.13%, 4.32% to 8.66%, and ≤ 0.95 .

Inter-day repeatability analysis results and averages for different concentrations of Cd have been calculated. The results of five different recovery studies show REC%, RSD%, and SD values ranging, respectively, from 87.50% to 102.90%, 2.6% to 10.32%, and ≤ 0.48 .

The average larval length was calculated by measuring five randomly selected third-instar larvae from each blank, As-spiked, and Cd-spiked group (n=5) (Fig. 4).

Figure 4. Average length of third-instar larvae reared on blank, As-spiked, and Cd-spiked feeding media (n=5 larvae per group).



The graphical representation of the findings of As and Cd in larvae corresponding to the concentrations of As and Cd in the feeding media is presented in Fig. 5 and Fig. 6. Within the context of the obtained linearity formula, the correlation coefficients for As and Cd have been determined to be 0.677 and 0.902, respectively.

Figure 5. Relationship between As concentration in the feeding media and As concentration detected in *L. sericata* larvae.

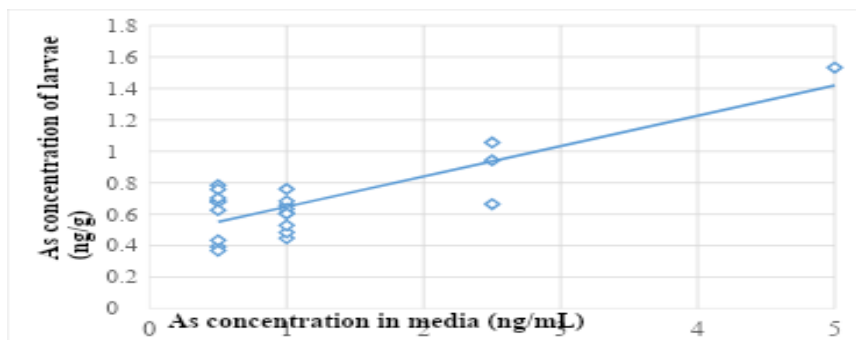
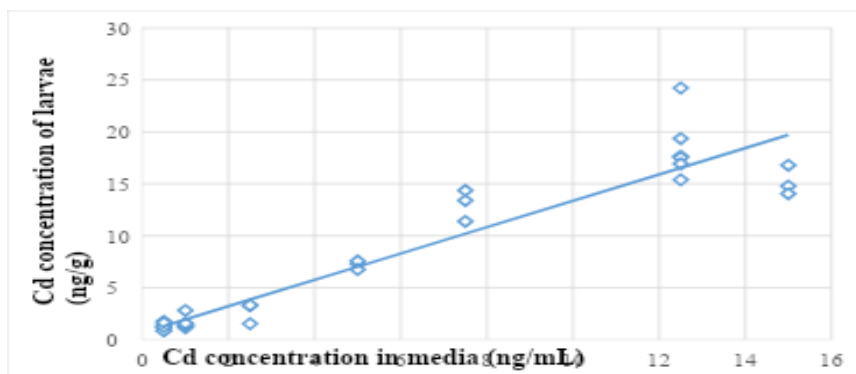


Figure 6. Relationship between Cd concentration in the feeding media and Cd concentration detected in *L. sericata* larvae.



Discussion

In a fatal case, a crime scene investigator's primary responsibility is to find evidence that can be used to determine the cause of death and oversee its correct collection and transfer. Determining the cause of death can be challenging in cases involving partial or complete decomposition of the deceased body. In such circumstances, the interaction between necrophagous insects and the decomposed body can reveal significant information about the cause of death within the framework of entomotoxicology, which provides an alternative approach in forensic investigations^{16,46}.

This study developed a method for analyzing fly larvae of the species *L. sericata* fed with a food source contaminated by As and Cd. With this method, the growth rates, survival percentages, and the extent to which larvae fed with food sources containing As and Cd

at different concentrations contain these elements were determined, along with the highest and lowest concentrations of As and Cd identified using ICP-MS.

Since there is no certified reference material developed for the larval matrix, recovery, accuracy, repeatability (intra-day and inter-day), matrix effect, and linearity studies were conducted using the standard addition method with blank larvae grown in a blank feeding medium. Two separate calibration curves were generated using calibration standards added to a 2% HNO₃ solution and the larval matrix, and in both linearity studies, the correlation coefficients for As and Cd elements were found to be >0.999.

The study did not evaluate concentrations below 0.5 µg/mL for As and Cd. The ICP-MS results at 0.5 µg/mL for both analytes were close to the LOQ values. Results from larvae grown at lower concentrations were expected to fall below the LOQ value.

The linear range obtained from the calibration solutions was 0.1–100 ng/mL for As and Cd, while the linear range obtained from the matrix-matched calibration curve was 1–20 ng/mL. Repeatability experiments revealed that RSD% values for 1, 2, 5, 10, and 20 ng/mL ranged from 3.46% to 8.51% for As and from 2.22% to 10.36% for Cd. The obtained RSD% values show that the analysis is reproducible. The developed method was shown to be repeatable and accurate, with RSD% values lower than 20% for all concentrations of both elements. In recovery trials evaluating the efficiency of the sample preparation procedure, REC% values for As at 1, 2, 5, 10, and 20 ng/mL were found to be between 94.33% and 107.38%, while REC% values for Cd at the same concentrations were between 97.98% and 108.16%.

Inter-day repeatability studies conducted on the same concentrations on different days showed that there was no statistically significant difference for As ($p>0.05$; 95% CI), while for Cd, statistically significant results were found at concentrations of 1 and 20 ng/mL ($p<0.05$; 95% CI). No significant difference was observed between the other concentrations ($p>0.05$; 95% CI).

Temperature, humidity, feeding media composition, and egg transfer conditions are among the factors that influence the larval growth curve⁴⁷. According to the body length analysis study by Bugelli et al. on *L. sericata* larvae, the average larval length in the third instar was determined to be 1.35 cm⁴⁸. In another study, larvae grown on heart tissue exhibited an average length ranging from 1.5 to 1.6 cm⁴⁹. In our study, the larvae reared in the blank group had an average length of 1.16 cm. However, as shown in Fig. 4, larvae fed with As and Cd exhibited a shorter length than this level, indicating that these toxic elements have a negative impact on larval growth. Furthermore, the same figure demonstrates a noticeable decrease in larval size as As and Cd concentrations increase, leading us to conclude that higher concentrations of these elements also negatively affect larval development. When larvae grown in media containing As and Cd were compared to those grown in blank media containing no analytes, there was a statistically significant difference between the Blank-As and Blank-Cd series ($p<0.05$). However, no significant difference was observed between the As-Cd series. In light of these findings, both As and Cd elements were found to produce a delay in the larval growth curve. In this regard, our

findings are supported by a study that found Tl had a deleterious impact on the development of *L. sericata*⁵⁰.

The quantities of As and Cd detected in the larvae provide a forensic basis for inferring exposure to these toxic elements in the feeding media and, by extension, in decomposed tissues when conventional biological matrices are unavailable. Previous entomotoxicological studies have demonstrated that necrophagous larvae are capable of absorbing and retaining xenobiotics from the tissues on which they feed, enabling toxicological screening and interpretation in advanced decomposition cases^{16,17}. While early applications of entomotoxicology focused primarily on drugs and organic toxicants, subsequent investigations have shown that inorganic elements can also be detected and quantified in larvae using ICP-MS, particularly in the context of GSR analysis involving Pb, Ba, and Sb^{18,46}.

More recent studies have expanded this framework to heavy metals, reporting bioaccumulation of Cd and other elements across different developmental stages of *L. sericata* and related blowfly species, with insect concentrations reflecting exposure levels in the feeding media^{21,25}. In the present study, Cd showed a stronger relationship between the concentration in the feeding media and the concentration detected in larvae than As, as indicated by the higher correlation coefficient obtained for Cd. This difference may be associated with element-specific differences in accumulation and biological handling, as well as with the effective exposure range observed in the experiment. Previous studies have reported the accumulation and body burden of Cd in biological tissues, suggesting that Cd may be retained more consistently after exposure^{36,39-42}. Therefore, Cd concentrations detected in larvae may more closely reflect the concentrations present in the feeding media. In contrast, it may show a less consistent relationship with the feeding substrate due to differences in uptake, distribution, metabolism, and elimination processes^{26,31}. In addition, larval development was observed over a wider concentration range for Cd, whereas As exposure allowed larval development only at lower concentrations. This narrower effective exposure range for As may have contributed to increased variability in larval As concentrations and, consequently, to the lower correlation coefficient observed for As.

Taken together, these findings support the interpretation that the detection and quantification of As and Cd in larvae can provide meaningful toxicological information regarding ante-mortem exposure, particularly in cases where blood or soft tissues are no longer available. This integrated interpretation, grounded in prior entomotoxicological and inorganic analytical studies, reinforces the applicability of larval elemental analysis as a complementary tool in forensic investigations of suspected poisoning. In real forensic casework, the proposed approach may be particularly useful as a complementary toxicological method in advanced decomposition cases, where conventional matrices such as blood, urine, or internal organs may be unavailable, degraded, or unsuitable for analysis^{16,17}. In such cases, necrophagous larvae collected from the body or the death scene may provide alternative material for detecting inorganic toxic elements, especially when analyzed by sensitive techniques such as ICP-MS^{21,25,46}. However, larval elemental

analysis should not be interpreted as a direct substitute for conventional toxicological matrices. Element concentrations in larvae may be influenced by insect species, developmental stage, feeding duration, tissue type, substrate heterogeneity, environmental contamination, and element-specific toxicokinetic behavior. Therefore, results should be interpreted together with scene findings, autopsy observations, available tissue analyses, and environmental or blank controls. Further validation using different tissues, decomposition stages, insect species, and realistic forensic scenarios is needed before larval concentrations can be used for direct quantitative estimation of ante-mortem exposure.

Conclusion

This study demonstrates that data obtained from larvae can provide valuable information about the concentrations of substances present in the feeding media. The analytical method developed and validated for the analysis of As and Cd in *L. sericata* larvae stands out as an applicable method for the analysis of other inorganic elements as well.

In conclusion, the ICP-MS-based method developed in this study enabled the detection and quantification of As and Cd in *L. sericata* larvae with acceptable recovery, repeatability, and reproducibility. The findings indicate that As and Cd exposure may negatively affect larval development and that larval elemental concentrations, particularly for Cd, may reflect the concentrations present in the feeding media. Therefore, larval elemental analysis may contribute to the evaluation of rare post-mortem poisoning cases, especially when conventional biological matrices are unavailable.

It is suggested that this research be advanced by conducting further studies at various concentrations and by developing feeding media using alternative experimental animal models. This will contribute to the expansion of entomotoxicological research in forensic sciences and may allow findings obtained from larvae to guide the elucidation of post-mortem poisoning.

REFERENCES

1. Catts EP, Goff ML. Forensic entomology in criminal investigations. *Annu Rev Entomol.* 1992;37(1):253-272. doi: 10.1146/annurev.en.37.010192.001345
2. Joseph I, Mathew D, Sathyan P, Vargheese G. The use of insects in forensic investigations: an overview on the scope of forensic entomology. *J Forensic Dent Sci.* 2011;3(2):89.

3. Amendt J, Campobasso CP, Gaudry E, Reiter C, LeBlanc HN, JR. Hall M. Best practice in forensic entomology—standards and guidelines. *Int J Legal Med.* 2007;121(2):90-104.
4. Benecke M. Six Forensic Entomology Cases: Description and Commentary. *J Forensic Sci.* 1998;43(4):797-805. doi: 10.1520/JFS14309J
5. Sohal RS, Lamb RE. Intracellular deposition of metals in the midgut of the adult housefly, *Musca domestica*. *J Insect Physiol.* 1977;23(11-12):1349-1354.
6. Sohal RS, Lamb RE. Storage-excretion of metallic cations in the adult housefly, *Musca domestica*. *J Insect Physiol.* 1979;25(2):119-124. doi: 10.1016/0022-1910(79)90089-1
7. Beyer J, Enos W, Stajić M. Drug identification through analysis of maggots. *J Forensic Sci.* 1980;25(2):411-412. doi: 10.1520/JFS12147J
8. Wilson Z, Hubbard S, Pounder DJ. Drug analysis in fly larvae. *Am J Forensic Med Pathol.* 1993;14(2):118-120. doi: 10.1097/00000433-199306000-00002
9. Sadler DW, Fuke C, Court F, Pounder DJ. Drug accumulation and elimination in *Calliphora vicina* larvae. *Forensic Sci Int.* 1995;71(3):191-197. doi: 10.1016/0379-0738(94)01663-1
10. Levine B, Golle M, Smialek JE. An Unusual Drug Death Involving Maggots: *Am J Forensic Med Pathol.* 2000;21(1):59-61. doi: 10.1097/00000433-200003000-00010
11. Rezende F, Alonso MA, Souza CM, Thyssen PJ, Linhares AX. Developmental rates of immatures of three Chrysomya species (Diptera: Calliphoridae) under the effect of methylphenidate hydrochloride, phenobarbital, and methylphenidate hydrochloride associated with phenobarbital. *Parasitol Res.* 2014;113(5):1897-1907.
12. Kintz P, Tracqui A, Mangin P. Analysis of opiates in fly larvae sampled on a putrefied cadaver. *J Forensic Sci Soc.* 1994;34(2):95-97. doi: 10.1016/S0015-7368(94)72890-5
13. Bourel B, Fleurisse L, Hédouin V, et al. Immunohistochemical contribution to the study of morphine metabolism in calliphoridae larvae and implications in forensic entomotoxicology. *J Forensic Sci.* 2001;46(3):596-599. doi: 10.1520/JFS15009J
14. Kharbouche H, Augsburger M, Cherix D, et al. Codeine accumulation and elimination in larvae, pupae, and imago of the blowfly *Lucilia sericata* and effects on its development. *Int J Legal Med.* 2008;122(3):205-211. doi: 10.1007/s00414-007-0217-z

15. Nuorteva P, Nuorteva SL. The fate of mercury in sarcosaprophagous flies and in insects eating them. *Ambio*. 1982;11(1):34-37.
16. Nolte K, Pinder R, Lord W. Insect larvae used to detect cocaine poisoning in a decomposed Body. *J Forensic Sci*. 1992;37(4):1179-1185. doi: 10.1520/JFS13304J
17. Amendt J, Richards CS, Campobasso CP, Zehner R, Hall MJR. Forensic entomology: applications and limitations. *Forensic Sci Med Pathol*. 2011;7(4):379-392.
18. Roeterdink EM, Dadour IR, Watling RJ. Extraction of gunshot residues from the larvae of the forensically important blowfly *Calliphora dubia* (Macquart) (Diptera: Calliphoridae). *Int J Legal Med*. 2004;118(2):63-70. doi: 10.1007/s00414-003-0408-1
19. Rashid RA, Arifuddin N, Ahmad NW. Blowfly, *Chrysomya megacephala* as an alternative specimen in determination of gunshot residue. In: *2012 IEEE Symposium on Business, Engineering and Industrial Applications*. IEEE; 2012:542-547.
20. Cil M, Mercan S, Cakan H. Prediction of the number of firearm shots by using *Lucilia sericata* (Diptera: Calliphoridae) larvae with an inductively coupled plasma -mass spectrometry (ICP-MS) technique. *Entomol News*. 2025;132(3).
21. Boulkenafet F, Bouhayene S, Benzazia S, et al. Heavy metal bioaccumulation in rabbit organs and *Chrysomya albiceps* (Wiedemann, 1819) larvae: implications for forensic entomology. *Indian J Anim Res*. 2024;(Of). doi:10.18805/IJAR.BF-1745
22. Anderson G. Insect succession on carrion and its relationship to determining time of death. In: *Forensic Entomology: The Utility of Arthropods in Legal Investigations*. 2000:143-175.
23. Dadour IR, Cook DF, Fissioli JN, Bailey WJ. Forensic entomology: application, education and research in Western Australia. *Forensic Sci Int*. 2001;120(1-2):48-52.
24. Kökdener M, Yılmaz AF. The effects of gunshot residue components (Pb, Ba, and Sb) on the life history traits of *Lucilia sericata* (Diptera: Calliphoridae). Lysyk T, ed. *J Med Entomol*. 2021;58(6):2130-2137. doi: 10.1093/jme/tjab123
25. Malejko J, Deoniziak K, Tomczuk M, Długokencka J, Godlewska-Żyłkiewicz B. Puparial cases as toxicological indicators: bioaccumulation of cadmium and thallium in the forensically important blowfly *Lucilia sericata*. *Front Chem*. 2020;8:586067.

- 26.** Hughes MF, Beck BD, Chen Y, Lewis AS, Thomas DJ. Arsenic exposure and toxicology: a historical perspective. *Toxicol Sci.* 2011;123(2):305-332. doi: 10.1093/toxsci/kfr184
- 27.** Vahidnia A, Van Der Voet GB, De Wolff FA. Arsenic neurotoxicity — A review. *Hum Exp Toxicol.* 2007;26(10):823-832. doi: 10.1177/0960327107084539
- 28.** Chen QY, Costa M. Arsenic: A global environmental challenge. *Annu Rev Pharmacol Toxicol.* 2021;61(1):47-63. doi: 10.1146/annurev-pharmtox-030220-013418
- 29.** Bissen M, Frimmel FH. Arsenic — a Review. Part I: occurrence, toxicity, speciation, mobility. *Acta Hydrochim Hydrobiol.* 2003;31(1):9-18. doi: 10.1002/aheh.200390025
- 30.** Smedley PL, Kinniburgh DG. A review of the source, behaviour and distribution of arsenic in natural waters. *Appl Geochem.* 2002;17(5):517-68.
- 31.** Marchiset-Ferlay N, Savanovitch C, Sauvant-Rochat MP. What is the best biomarker to assess arsenic exposure via drinking water? *Environ Int.* 2012;39(1):150-171. Kile ML, Hoffman E, Hsueh YM, et al. Variability in Biomarkers of Arsenic Exposure and Metabolism in Adults over Time. *Environ Health Perspect.* 2009;117(3):455-460.
- 32.** Loffredo CA, Aposhian HV, Cebrian ME, Yamauchi H, Silbergeld EK. Variability in human metabolism of arsenic. *Environ Res.* 2003;92(2):85-91.
- 33.** Meija J, Coplen TB, Berglund M, et al. Atomic weights of the elements 2013 (IUPAC Technical Report). *Pure Appl Chem.* 2016;88(3):265-291. doi: 10.1515/pac-2015-0305
- 34.** Norman NC, ed. *Chemistry of Arsenic, Antimony and Bismuth*. 1. ed. Blackie Academic & Professional; 1998.
- 35.** Satarug S. Cadmium sources and toxicity. *Toxics.* 2019;7(2):25.
- 36.** Satarug S. Dietary Cadmium Intake and Its Effects on Kidneys. *Toxics.* 2018;6(1):15.
- 37.** Kumar S, Sharma A. Cadmium toxicity: effects on human reproduction and fertility. *Rev Environ Health.* 2019;34(4):327-338. doi: 10.1515/reveh-2019-0016
- 38.** Salmela SS, Vuori E, Huunan-Seppälä A, Kilpiö JO, Sumuvuori H. Body burden of cadmium in man at low level of exposure. *Sci Total Environ.* 1983;27(1):89-95.
- 39.** Vuori E, Huunan-Seppälä A, Kilpiö JO, Salmela SS. Biologically active metals in human tissues. II. The effect of age on the concentration of cadmium in aorta,

heart, kidney, liver, lung, pancreas and skeletal muscle. *Scand J Work Environ Health*. 1979;5(1):16-22.

40. Kjellström T. Exposure and accumulation of cadmium in populations from Japan, the United States, and Sweden. *Environ Health Perspect*. 1979;28:169-197.
41. Subhan F, Khan A, Wahid F, Shehzad A, Jan AU. Determination of Optimal Toxic Concentration and Accumulation of Cadmium in Broiler Chicks. *Toxicol Res*. 2011;27(3):143-147. doi: 10.5487/TR.2011.27.3.143
42. Hsu CW, Weng CH, Lin-Tan DT, et al. Association of Urinary Cadmium with Mortality in Patients at a Coronary Care Unit. Kokubo Y, ed. *PLoS One*. 2016;11(1):e0146173.
43. Ammann AA. Inductively coupled plasma mass spectrometry (ICP MS): a versatile tool. *J Mass Spectrom*. 2007;42(4):419-427. doi: 10.1002/jms.1206
44. Wilschefske SC, Baxter MR. Inductively Coupled Plasma Mass Spectrometry: Introduction to Analytical Aspects. *Clin Biochem Rev*. 2019;40(3):115-133.
45. Costa RA, Dos Santos NA, Corrêa TSM, et al. Detection of Pb, Ba, and Sb in Cadaveric Maggots and Pupae by ICP-MS. *J Forensic Sci*. 2020;65(6):2188-2193.
46. Roe A, Higley LG. Development modeling of *Lucilia sericata* (Diptera: Calliphoridae). *PeerJ*. 2015;3:e803. doi: 10.7717/peerj.803
47. Bugelli V, Campobasso CP, Verhoff MA, Amendt J. Effects of different storage and measuring methods on larval length values for the blow flies (Diptera: Calliphoridae) *Lucilia sericata* and *Calliphora vicina*. *Sci Justice*. 2017;57(3):159-164.
48. Bambaradeniya TB, Magni PA, Dadour IR. Morphological changes of larvae and pupae of *Lucilia sericata* (Diptera: Calliphoridae) reared at two temperatures and on three food types. Byrd J, ed. *J Med Entomol*. 2024;61(3):521-529. doi: 10.1093/jme/tjae013
49. Altunsoy F, Başaran A. Effects of Thallium on the Larval Development of *Lucilia sericata* Meigen 1826 and PMI Estimation. *Anadolu Univ J Sci Technol C Life Sci Biotechnol*. 2011;1(2):103-112.

In Silico* Functional Assessment of COL4A3, COL4A4, and COL4A5 SNPs in Alport Syndrome

Beyza R meysa ERG NAL GE **, Tuğba KAMAN***, Mesut KARAHAN****

Abstract

Aim: Alport syndrome is a rare genetic disorder characterized by hematuria, proteinuria, progressive renal failure, and, in some cases, hearing and visual impairment. This study aims to identify and prioritize deleterious missense single-nucleotide polymorphisms (SNPs) in the *COL4A3*, *COL4A4*, and *COL4A5* genes associated with Alport syndrome and to evaluate their effects on protein stability and three-dimensional structure using an integrated multi-tool *in silico* approach.

Method: SNP data and protein amino acid sequences were obtained from the NCBI dbSNP and UniProt databases; these data were used as input in *in silico* analyses performed using various bioinformatics tools, including SIFT, PolyPhen-2, SNPs&GO, PANTHER, PROVEAN, SNAP2, Mutation Assessor, I-Mutant 2.0, MUpro, and Project HOPE, to evaluate the potential structural and functional effects on *COL4A3*, *COL4A4*, and *COL4A5* proteins. Only variants predicted as deleterious by all applied tools were selected for further analysis.

Results: A large number of SNPs were initially identified for *COL4A3*, *COL4A4*, and *COL4A5* genes; however, multi-tool consensus analysis identified 12, 14, and 146 deleterious missense variants in *COL4A3*, *COL4A4*, and *COL4A5*, respectively. Protein stability analyses produced divergent results: I-Mutant 2.0 predicted increased stability for 160 of 172 variants, whereas MUpro predicted decreased stability for 147 variants. In addition, a substantial number of deleterious variants involved glycine substitutions, which are likely to affect protein flexibility, folding, and intermolecular interactions, potentially impairing the structural integrity of the glomerular basement membrane.

Conclusion: This study represents a comprehensive consensus-based *in silico* evaluation of deleterious missense SNPs in *COL4A3*, *COL4A4*, and *COL4A5* genes. The findings highlight the potential role of glycine substitutions in disease pathogenesis and provide an important basis for future experimental studies.

Keywords: Alport syndrome, single nucleotide polymorphism, bioinformatics, *COL4A3*, *COL4A4*, *COL4A5*.

 zg n Arařtırma Makalesi (Original Research Article)

Geliř / Received: 04.05.2026 **Kabul / Accepted:** 20.08.2026

DOI: <https://doi.org/10.38079/igusabder.1944349>

* This study has been derived from the master's thesis titled "Analysis of Some Genes Associated with Alport Syndrome with Bioinformatic Tools", which was accepted in 2022 at  sk dar University Institute of Sciences Department of Molecular Biology and Genetics and prepared by Beyza R meysa ERG NAL under the consultancy of Asst. Prof. Tuğba KAMAN, Prof. Dr. Mesut KARAHAN.

** MSc in Molecular Biology and Genetics, Department of Molecular Biology and Genetics, Institute of Sciences,  sk dar University, Istanbul, T rkiye. E-mail: bevzaerginal@gmail.com [ORCID https://orcid.org/0000-0003-4536-7407](https://orcid.org/0000-0003-4536-7407)

*** Asst. Prof. Dr., Vocational School of Health Services, Medical and Aromatic Plants,  sk dar University, Istanbul, T rkiye. E-mail: tugba.kaman@uskudar.edu.tr [ORCID https://orcid.org/0000-0002-5885-0193](https://orcid.org/0000-0002-5885-0193)

**** Prof. Dr., Department of Nutrition and Dietetics, Faculty of Health Sciences, Istanbul Niřantař University, Istanbul, T rkiye. E-mail: mesut.karahan@nisantasi.edu.tr [ORCID https://orcid.org/0000-0002-8971-678X](https://orcid.org/0000-0002-8971-678X)

Alport Sendromunda COL4A3, COL4A4 ve COL4A5 SNP'lerinin İn Silico Fonksiyonel Değerlendirilmesi

Öz

Amaç: Alport sendromu, hematüri, proteinüri, ilerleyici böbrek yetmezliği ve bazı olgularda işitme ve görme bozuklukları ile karakterize nadir görülen bir genetik hastalıktır. Bu çalışma, Alport sendromuyla ilişkili COL4A3, COL4A4 ve COL4A5 genlerindeki olası patojenik yanlış anlamlı tek nükleotid polimorfizmlerini (SNP'leri) belirlemek ve önceliklendirmek ve bu SNP'lerin protein stabilitesi ve üç boyutlu yapısı üzerindeki etkilerini çoklu in silico yaklaşım kullanarak değerlendirmektir.

Yöntem: SNP verileri ve protein amino asit dizileri NCBI dbSNP ve UniProt veri tabanlarından elde edildi; bu veriler, COL4A3, COL4A4 ve COL4A5 proteinleri üzerindeki potansiyel yapısal ve fonksiyonel etkileri değerlendirmek amacıyla SIFT, PolyPhen-2, SNPs&GO, PANTHER, PROVEAN, SNAP2, Mutation Assessor, I-Mutant 2.0, MUPRO ve Project HOPE gibi çeşitli biyoenformatik araçları kullanılarak *in silico* analizler yapıldı. Kullanılan tüm araçlar tarafından zararlı olarak tahmin edilen varyantlar ileri analizler için seçildi.

Bulgular: Başlangıçta COL4A3, COL4A4 ve COL4A5 genlerinde çok sayıda SNP tespit edildi, ancak çoklu araçlara dayalı konsensüs analizi sonucunda sırasıyla 12, 14 ve 146 zararlı missense varyant tespit edildi. Protein stabilitesi analizleri farklı sonuçlar ortaya koymuştur: I-Mutant 2.0, 172 varyantın 160'ında stabilite artışı ön görürken MUPRO, 147 varyantta stabilite azalması öngörmüştür. Ayrıca, zararlı varyantların önemli bir kısmının glisin substitüsyonlarını içerdiği ve bu değişimlerin protein esnekliği, katlanması ve moleküller arası etkileşimleri etkileyerek glomerüler bazal membranın yapısal bütünlüğünü bozabileceği belirlenmiştir.

Sonuç: Bu çalışma, COL4A3, COL4A4 ve COL4A5 genlerindeki zararlı missense SNP'lerin konsensüs temelli kapsamlı bir *in silico* değerlendirmesini sunmaktadır. Elde edilen bulgular, özellikle glisin substitüsyonlarının hastalık patogenezindeki olası rolünü ortaya koymakta ve gelecekte yapılacak deneysel çalışmalar için önemli bir temel sağlamaktadır.

Anahtar Sözcükler: Alport sendromu, tek nükleotid polimorfizmi, biyoenformatik, COL4A3, COL4A4, COL4A5.

Introduction

Alport syndrome is a genetic kidney disorder characterized by blood in the urine, progressive kidney failure, hearing loss, and eye abnormalities. It is the second most common inherited cause of kidney failure after autosomal dominant polycystic kidney disease. In 1927, Arthur C. Alport reported a series of cases involving patients with familial hereditary nephritis. Although not the first to describe the condition, he was the first to establish the association between the renal manifestations and sensorineural hearing loss. Additionally, he observed that the disorder could be accompanied by ocular abnormalities. Following his death, the characteristic clinical features of renal disease, hearing impairment, and visual disturbances became known as Alport syndrome¹.

Alport syndrome results from mutations in the COL4A3, COL4A4, and COL4A5 genes, which encode the $\alpha 3$, $\alpha 4$, and $\alpha 5$ chains of type IV collagen, an essential structural component of the glomerular basement membrane (GBM) in the kidney. To date, over 500 distinct mutations affecting these genes have been identified, with the majority exhibiting X-linked or autosomal recessive patterns of inheritance^{2,3}.

The *COL4A5* gene is located on the X chromosome. Hemizygous males carrying pathogenic variants in *COL4A5* are typically more severely affected. However, heterozygous female carriers may exhibit a spectrum of clinical manifestations, ranging from isolated hematuria to progressive renal decline and end-stage renal disease (ESRD)^{3,4}. Loss of any one of the type IV collagen α chains disrupts the formation of the $\alpha3\alpha4\alpha5$ heterotrimer, which is essential for the structural integrity of the glomerular basement membrane (GBM). The clinical phenotype and disease course of males with autosomal recessive Alport syndrome due to biallelic pathogenic variants in *COL4A3* or *COL4A4* are usually very similar to those of hemizygous males with X-linked Alport syndrome due to pathogenic *COL4A5* variants. In contrast, due to X-chromosome inactivation, female carriers of pathogenic *COL4A5* variants may have a higher risk of developing ESRD than heterozygous carriers of pathogenic *COL4A3* or *COL4A4* variants associated with autosomal recessive Alport syndrome⁵.

A detailed physical examination with a family history should be performed for diagnosis. Laboratory evaluation should encompass urinalysis, urine microscopy, and assessment of renal function. Individuals with Alport syndrome commonly present with hematuria, proteinuria, edema, hypertension, and progressive deterioration of kidney function, which may culminate in end-stage renal disease (ESRD). As the disease advances, clinical parameters typically worsen, marked by increasing levels of proteinuria, rising blood pressure, declining glomerular filtration rate (GFR), and eventual development of ESRD. The onset of ESRD most frequently occurs between the ages of 16 and 35 years⁶.

Due to abnormalities in type IV collagen in the inner ear, individuals with Alport syndrome frequently develop bilateral sensorineural hearing loss in late childhood. High-frequency hearing loss is typically the initial manifestation, emerging in late infancy or early adolescence, preceding the onset of kidney failure⁷.

Patients with Alport syndrome may exhibit various ocular symptoms. Affected individuals may experience anterior lenticonus, a cone-shaped lens that leads to aberrant refraction and reduced visual acuity. Cataracts, dystrophy, corneal damage, and aberrant pigment changes in the retina with yellow or white spots (spot and speckle retinopathy) are further problems⁸⁻¹¹.

Early diagnosis of Alport syndrome is critical, as, depending on the stage of the disease at which treatment is initiated, pharmacological inhibition of the renin-angiotensin-aldosterone system (RAAS) can reduce the progression to end-stage renal disease (ESRD)^{3,12}.

The renin-angiotensin-aldosterone system plays a key role in regulating blood flow in the kidneys, ensuring proper salt and water balance, and influencing tissue development within renal structures.

Activation of the renin-angiotensin-aldosterone system (RAAS) contributes to both systemic and glomerular capillary hypertension, leading to hemodynamic injury in the vascular endothelium and glomeruli. Recognizing the role of this system is important, as

blocking its activity can help slow the progression of chronic kidney disease in patients with proteinuria.

Although current treatments do not offer a cure, they can substantially slow the progression to kidney failure, especially when started before any decline in glomerular filtration rate (GFR)¹². Since early intervention can modify the course of Alport nephropathy, timely diagnosis of Alport syndrome is critically important.

Genes Associated with Alport Syndrome

The *COL4A5* gene encodes one of the six subunits of type IV collagen, which is a key structural component of basement membranes. Mutations in this gene are associated with X-linked Alport syndrome, also referred to as hereditary nephritis¹³.

The *COL4A4* gene encodes one of the six subunits of type IV collagen, a major structural component of basement membranes. However, this specific subunit is expressed only in certain types of basement membranes. Mutations in *COL4A4* are associated with autosomal recessive Alport syndrome (type II) as well as with benign familial hematuria, also known as thin basement membrane disease¹⁴.

The *COL4A3* gene encodes one of the alpha subunits of type IV collagen, a multimeric protein that serves as a key structural component of basement membranes. Type IV collagen is composed of three alpha chains that form a triple helix structure. These chains are encoded by six distinct genes (*COL4A1* to *COL4A6*), each contributing to the assembly of specific α -chain combinations. Mutations in *COL4A3* are associated with the autosomal recessive form of Alport syndrome¹⁵.

Polymorphism

Genetic polymorphisms arise from variations in genetic material among individuals and populations. Variants with a population frequency greater than 1% are generally referred to as polymorphisms, whereas those with lower frequencies are considered rare variants.¹⁶

Single Nucleotide Polymorphism

Single-nucleotide polymorphisms (SNPs) are the most common type of genetic variation in the human genome. The human genome is estimated to contain approximately 3–10 million SNPs. SNPs that directly affect protein structure and function are typically located in coding regions of DNA. However, SNPs located in regulatory regions may also alter gene expression and contribute to phenotypic variation or disease susceptibility. In contrast, SNPs that do not significantly affect gene function or phenotype are referred to as neutral SNPs¹⁷.

SNPs serve as valuable genetic markers for identifying disease-associated genes. Single-nucleotide polymorphisms (SNPs) located within a gene or its regulatory regions may directly influence disease by altering gene function. They are also useful markers for

tracing the inheritance of disease-related genes within families. Therefore, further research is essential to uncover SNPs linked to complex conditions such as cardiovascular disease, diabetes, and cancer¹⁸.

There are several databases that the public can access for SNPs. SNPs are especially significant when they arise in coding regions, as non-synonymous variants can induce alterations in the amino acid sequence. SNPs are likely to play an important role in the functional diversity of encoded proteins in human populations and are associated with many diseases. SNPs can influence gene regulation by altering protein function, affecting transcriptional and translational processes, and modifying protein stability or solubility^{19,20}.

Databases for Single Nucleotide Polymorphism Analysis

Due to the large number of genetic polymorphisms in the human genome, extensive research is required to identify disease susceptibility and support personalized drug design²¹. However, to facilitate these studies, numerous computational methods are used to identify potentially important variants before performing *in vitro* or *in vivo* testing. Therefore, *in silico* approaches represent effective bioinformatics tools to distinguish harmful SNPs from neutral ones using certain algorithms²².

The overall effect of polymorphism, including functional and structural changes, can be analyzed through various databases. Consequently, bioinformatics tools play a crucial role in identifying and prioritizing potentially deleterious SNPs, as experimental validation of every variant is impractical. As a preliminary study, these bioinformatics approaches offer an effective filtering strategy to assess whether the identified SNPs are deleterious or neutral²³.

Given the genetic heterogeneity of Alport syndrome, identifying high-confidence deleterious variants in COL4A3, COL4A4, and COL4A5 genes is of critical importance. In this context, this study provides a comprehensive consensus-based prioritization of deleterious missense variants (i.e., variants predicted as deleterious by all applied *in silico* tools), aiming to improve the reliability of variant prioritization and to support future genetic and experimental studies in Alport syndrome.

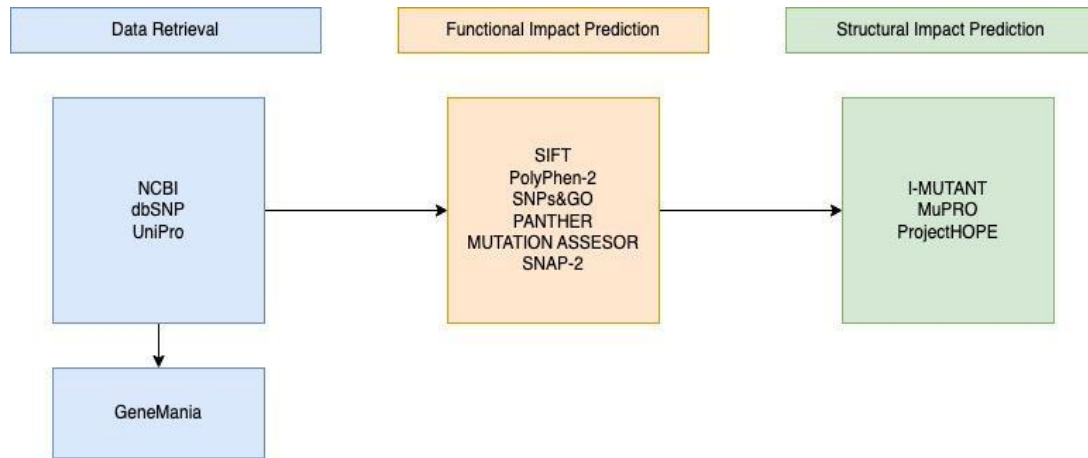
Material and Methods

Type of Research

This study is an *in silico* analysis of the COL4A3, COL4A4, and COL4A5 genes associated with Alport syndrome using a variety of publicly available bioinformatics tools. *In silico* analyses can be used to predict deleterious SNPs in the COL4A3, COL4A4, and COL4A5 genes associated with Alport syndrome, enabling the selection of target SNPs for genotyping in disease association studies. Therefore, the findings of this study may facilitate future experimental validation studies.

Workflow Chart

Figure 1. The *in silico* tools used, and the analysis workflow are presented as a schematic diagram.



Data Mining

The NCBI dbSNP database was used to access SNPs in the *COL4A3*, *COL4A4*, and *COL4A5* genes in January 2021. SNPs in these three genes were selected for analysis. The amino acid sequences of the encoded proteins were obtained from the UniProt database²⁴.

Bioinformatics Data Analysis

SIFT (Sorting Intolerant From Tolerant; accessed in February 2021), PolyPhen-2 (Prediction of functional effects of human nsSNPs; accessed in February 2021), SNPs&GO (Predicting human disease-related mutations in proteins with functional annotations; accessed in April 2021), PANTHER (Protein Analysis Through Evolutionary Relationships; accessed in July 2021), PROVEAN (Protein Variation Effect Analyzer; accessed in July 2021), Mutation Assessor (accessed in August 2021), and SNAP2 (SNP effect predictor; accessed in August 2021) bioinformatics tools were used to evaluate the effects of SNPs on protein structure and function.

SIFT predicts the functional impact of amino acid substitutions by analyzing sequence homology and the physicochemical characteristics of amino acids. Variants with SIFT scores ≤ 0.05 were classified as deleterious, whereas those with scores > 0.05 were classified as tolerated^{25,26}.

PolyPhen-2 assesses the structural and functional consequences of amino acid alterations in specific proteins. Variants classified as “possibly damaging” or “probably damaging” were considered potentially deleterious²⁷.

SNPs&GO integrates functional annotation data to evaluate the likelihood of a single nucleotide polymorphism being disease-associated. Variants with a disease probability >0.5 were classified as disease-associated.

PROVEAN estimates the potential deleterious effects of amino acid substitutions on protein function. Variants with PROVEAN scores ≤ -2.5 were considered deleterious, whereas scores > -2.5 were considered neutral²⁸.

PANTHER evaluates the probable impact of missense variants on the functional integrity of target proteins. Variants classified as “probably damaging” or “possibly damaging” were considered potentially deleterious, whereas variants classified as “probably benign” were considered non-deleterious.

Mutation Assessor classifies variants according to their predicted functional impact as neutral, low, medium, or high; variants classified as having medium or high functional impact were considered potentially deleterious. SNAP2 predictions with scores >0 were considered to have an effect, whereas scores ≤ 0 were considered neutral²⁹.

Only variants consistently predicted to be deleterious or functionally damaging by all seven functional prediction tools were included in the consensus deleterious variant set and subjected to subsequent protein stability and structural analyses.

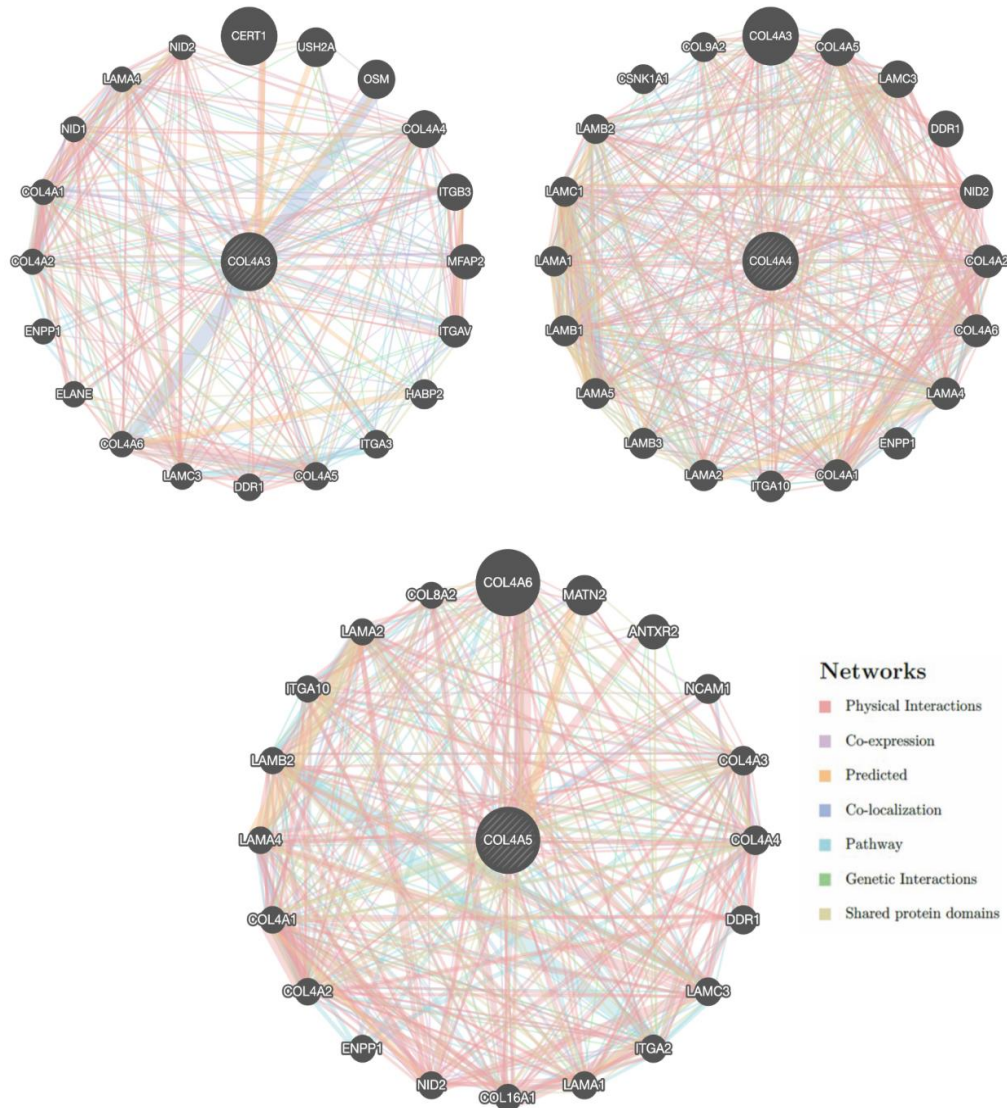
The effects of these consensus deleterious variants on protein stability were evaluated using I-Mutant 2.0 and MUpro (accessed in August 2021). MUpro analyses were performed using the protein sequence as input. MUpro provides two distinct prediction outputs: an estimated $\Delta\Delta G$ value generated using a support vector machine (SVM) regression model and a prediction of the direction of stability change generated using a separate classification model. Therefore, the predicted $\Delta\Delta G$ value should not be interpreted as the confidence score of the stability classification. Since these outputs are generated using different prediction methodologies, they may not always be concordant^{30,31}.

Three-dimensional structural interpretation of amino acid substitutions was performed using the Project HOPE tool (accessed in August 2021). Unless otherwise specified, the default parameters provided by the respective web tools were used³².

Gene–gene interactions

In addition, co-expression patterns and gene localization were analyzed using the GeneMANIA tool³³.

Figure 2. Gene-gene interactions of COL4A3, COL4A4, and COL4A5.



Results

The amino acid substitutions identified in each gene were analyzed using SIFT, SNPs&GO, PolyPhen-2, PANTHER, PROVEAN, SNAP2, and Mutation Assessor. A summary table of all analyzed genes and the corresponding results obtained from each database was prepared (Table 1). The variants associated with the disease in these databases were then analyzed with I-Mutant and MUpro software tools, and their effects on protein stabilization were investigated.

Table 1. List of deleterious SNPs identified in COL4A3, COL4A4, and COL4A5 genes.

COL4A3	COL4A4	COL4A5						
rs375290088	rs377511303	rs104886043	rs104886080	rs104886111	rs104886139	rs104886173	rs104886210	rs104886245
rs374787000	rs374815903	rs104886052	rs104886082	rs104886112	rs104886140	rs104886174	rs104886211	rs104886246
rs372237167	rs371191979	rs104886055	rs104886083	rs104886115	rs104886141	rs104886176	rs104886212	rs104886247
rs371185804	rs373150214	rs104886056	rs104886084	rs104886116	rs104886142	rs104886177	rs104886214	rs104886248
rs368351146	rs374340855	rs104886057	rs104886085	rs104886117	rs104886143	rs104886179	rs104886215	rs104886250
rs375040636	rs371817534	rs104886059	rs104886086	rs104886118	rs104886144	rs104886180	rs104886218	rs104886251
rs267606745	rs372606845	rs104886060	rs104886088	rs104886119	rs104886145	rs104886182	rs104886219	rs104886252
rs267599232	rs370474706	rs104886061	rs104886091	rs104886120	rs104886147	rs104886183	rs104886221	rs104886253
rs199956740	rs371172166	rs104886062	rs104886092	rs104886121	rs104886150	rs104886184	rs104886223	rs104886255
rs190598500	rs371915593	rs104886063	rs104886093	rs104886122	rs104886151	rs104886185	rs104886224	rs104886257
rs121912827	rs370917166	rs104886066	rs104886096	rs104886125	rs104886153	rs104886186	rs104886225	rs104886261
rs121912826	rs267599231	rs104886067	rs104886097	rs104886126	rs104886157	rs104886188	rs104886228	rs104886263
	rs267599228	rs104886068	rs104886098	rs104886127	rs104886158	rs104886189	rs104886229	rs104886264
	rs202242354	rs104886069	rs104886099	rs104886129	rs104886160	rs104886190	rs104886231	rs104886266
		rs104886070	rs104886100	rs104886130	rs104886161	rs104886191	rs104886232	rs104886267
		rs104886073	rs104886101	rs104886133	rs104886163	rs104886195	rs104886235	rs104886269
		rs104886074	rs104886102	rs104886134	rs104886165	rs104886196	rs104886236	rs104886272
		rs104886075	rs104886103	rs104886135	rs104886166	rs104886199	rs104886237	rs104886273
		rs104886076	rs104886105	rs104886136	rs104886168	rs104886201	rs104886240	rs104886274
		rs104886078	rs104886107	rs104886137	rs104886171	rs104886202	rs104886242	rs201220208
		rs104886079	rs104886108	rs104886138	rs104886172	rs104886209	rs104886244	

It should be noted that the $\Delta\Delta G$ values and the Increase/Decrease classifications reported by MUpPro are generated by distinct prediction models and may therefore not always be concordant.

Table 2. The effect of SNPs predicted to be deleterious by all software tools used on protein stabilization was determined with I-Mutant and MUpro.

COL4A3					COL4A4				
SNP ID	I Mutant	RI	MUpro	ddG	SNP ID	I Mutant	RI	MUpro	ddG
rs375290088	Inc.	5	Dec.	-0.132	rs377511303	Inc.	4	Dec.	-0.084
rs374787000	Inc.	3	Dec.	-0.580	rs374815903	Inc.	3	Dec.	-0.494
rs372237167	Inc.	2	Dec.	-0.262	rs371191979	Inc.	2	Dec.	-0.241
rs371185804	Inc.	5	Dec.	-0.272	rs373150214	Inc.	6	Dec.	-0.227
rs368351146	Inc.	2	Dec.	-0.604	rs374340855	Inc.	5	Dec.	-0.586
rs375040636	Inc.	4	Inc.	0.072	rs371817534	Inc.	5	Dec.	-0.843
rs267606745	Dec.	0	Dec.	-0.525	rs372606845	Inc.	4	Inc.	0.040
rs267599232	Inc.	5	Dec.	-0.278	rs370474706	Inc.	4	Dec.	-0.227
rs199956740	Inc.	3	Dec.	-0.202	rs371172166	Inc.	4	Dec.	-0.603
rs190598500	Inc.	4	Dec.	-0.247	rs371915593	Inc.	2	Dec.	-0.253
rs121912827	Inc.	6	Dec.	-0.186	rs370917166	Inc.	2	Dec.	-0.746
rs121912826	Inc.	4	Dec.	-0.586	rs267599231	Inc.	2	Dec.	-0.901
					rs267599228	Inc.	5	Dec.	-0.112
					rs202242354	Inc.	2	Dec.	-10.171
COL4A5									
SNP ID	I Mutant	RI	MUpro	ddG	SNP ID	I Mutant	RI	MUpro	ddG
rs104886043	Inc.	3	Inc.	0.002	rs104886153	Dec.	0	Dec.	-0.201
rs104886052	Inc.	5	Dec.	-0.512	rs104886157	Inc.	0	Dec.	-1.310
rs104886055	Inc.	3	Dec.	-0.451	rs104886158	Inc.	3	Dec.	-0.507
rs104886056	Inc.	4	Dec.	-0.320	rs104886160	Inc.	5	Dec.	-0.145
rs104886057	Inc.	6	Dec.	-0.058	rs104886161	Inc.	4	Dec.	-0.754
rs104886059	Inc.	4	Dec.	-0.297	rs104886163	Inc.	5	Dec.	-0.131
rs104886060	Inc.	4	Dec.	-0.449	rs104886165	Inc.	5	Dec.	-0.058
rs104886061	Inc.	4	Dec.	-0.677	rs104886166	Inc.	4	Dec.	-0.348
rs104886062	Inc.	5	Dec.	-0.031	rs104886168	Inc.	7	Inc.	0.046
rs104886063	Inc.	5	Dec.	-0.647	rs104886171	Inc.	4	Dec.	-0.304

rs104886066	Inc.	6	Inc.	0.028	rs104886172	Inc.	4	Dec.	-0.357
rs104886067	Inc.	5	Dec.	-0.358	rs104886173	Inc.	2	Dec.	-0.689
rs104886068	Inc.	6	Dec.	-0.058	rs104886174	Inc.	3	Dec.	-12.704
rs104886069	Inc.	4	Dec.	-0.598	rs104886176	Inc.	5	Dec.	-0.252
rs104886070	Inc.	2	Dec.	-0.526	rs104886177	Inc.	2	Dec.	-0.085
rs104886073	Inc.	3	Dec.	-0.129	rs104886179	Inc.	6	Dec.	-0.635
rs104886074	Inc.	5	Dec.	-0.182	rs104886180	Inc.	7	Inc.	0.179
rs104886075	Inc.	2	Dec.	-0.800	rs104886182	Inc.	5	Dec.	-0.598
rs104886076	Inc.	5	Dec.	-0.283	rs104886183	Inc.	5	Dec.	-0.344
rs104886078	Inc.	3	Inc.	0.051	rs104886184	Inc.	4	Dec.	-0.294
rs104886079	Inc.	1	Dec.	-0.250	rs104886185	Inc.	4	Dec.	-0.193
rs104886080	Inc.	2	Dec.	-10.300	rs104886186	Inc.	4	Dec.	-0.407
rs104886082	Inc.	2	Dec.	-0.627	rs104886188	Inc.	5	Dec.	-0.278
rs104886083	Inc.	3	Inc.	0.030	rs104886189	Inc.	3	Dec.	-0.090
rs104886084	Inc.	4	Dec.	-0.430	rs104886190	Inc.	3	Dec.	-0.241
rs104886085	Inc.	3	Dec.	-0.497	rs104886191	Inc.	5	Dec.	-0.535
rs104886086	Inc.	2	Dec.	-0.461	rs104886195	Inc.	5	Inc.	0.007
rs104886088	Inc.	4	Dec.	-0.573	rs104886196	Inc.	4	Dec.	-0.336
rs104886091	Inc.	3	Dec.	-0.356	rs104886199	Inc.	4	Inc.	0.001
rs104886092	Inc.	2	Dec.	-0.247	rs104886201	Inc.	4	Dec.	-0.155
rs104886093	Inc.	2	Dec.	-0.430	rs104886202	Inc.	6	Inc.	0.010
rs104886096	Inc.	4	Inc.	0.089	rs104886209	Inc.	3	Dec.	-0.329
rs104886097	Inc.	6	Dec.	-0.160	rs104886210	Inc.	4	Dec.	-11.172
rs104886098	Inc.	5	Dec.	-0.379	rs104886211	Inc.	5	Inc.	0.070
rs104886099	Inc.	4	Inc.	0.226	rs104886212	Inc.	4	Inc.	0.1361
rs104886100	Inc.	4	Dec.	-0.293	rs104886214	Inc.	5	Dec.	-0.420
rs104886101	Dec.	1	Dec.	-0.554	rs104886215	Inc.	7	Inc.	0.107
rs104886102	Dec.	1	Dec.	-0.339	rs104886218	Dec.	2	Dec.	-0.416
rs104886103	Inc.	1	Dec.	-0.065	rs104886219	Dec.	1	Dec.	-1.233
rs104886105	Inc.	3	Dec.	-0.205	rs104886221	Dec.	0	Dec.	-15.651

rs104886107	Inc.	6	Dec.	-0.265	rs104886223	Dec.	5	Dec.	-0.385
rs104886108	Inc.	7	Dec.	-1.061	rs104886224	Inc.	3	Dec.	-0.145
rs104886111	Inc.	3	Dec.	-0.516	rs104886225	Inc.	3	Dec.	-0.110
rs104886112	Inc.	6	Inc.	0.273	rs104886228	Inc.	4	Dec.	-0.454
rs104886115	Inc.	4	Inc.	0.200	rs104886229	Inc.	4	Dec.	-0.335
rs104886116	Inc.	2	Dec.	-0.387	rs104886231	Inc.	5	Dec.	-0.206
rs104886117	Inc.	3	Dec.	-0.568	rs104886232	Inc.	4	Dec.	-0.095
rs104886118	Inc.	4	Dec.	-0.082	rs104886235	Inc.	6	Inc.	0.005
rs104886119	Inc.	2	Dec.	-0.671	rs104886236	Inc.	4	Dec.	-0.745
rs104886120	Inc.	5	Dec.	-0.048	rs104886237	Inc.	3	Dec.	-0.178
rs104886121	Inc.	3	Inc.	0.046	rs104886240	Inc.	5	Dec.	-0.735
rs104886122	Inc.	3	Dec.	-0.339	rs104886242	Inc.	4	Dec.	-0.099
rs104886125	Inc.	2	Dec.	-0.066	rs104886244	Inc.	5	Dec.	-0.304
rs104886126	Dec.	1	Dec.	-0.448	rs104886245	Inc.	5	Dec.	-0.799
rs104886127	Dec.	1	Dec.	-0.426	rs104886246	Inc.	4	Dec.	-0.160
rs104886129	Inc.	0	Dec.	-0.803	rs104886247	Inc.	6	Dec.	-0.049
rs104886130	Inc.	8	Dec.	-0.109	rs104886248	Inc.	5	Dec.	-0.077
rs104886133	Inc.	3	Dec.	-0.336	rs104886250	Inc.	6	Dec.	-0.144
rs104886134	Inc.	3	Dec.	-0.245	rs104886251	Inc.	3	Dec.	-0.068
rs104886135	Inc.	4	Dec.	0.411	rs104886252	Inc.	5	Dec.	-0.178
rs104886136	Inc.	3	Dec.	-0.625	rs104886253	Inc.	5	Dec.	-0.542
rs104886137	Inc.	7	Dec.	-0.437	rs104886255	Inc.	4	Dec.	-0.072
rs104886138	Inc.	4	Dec.	-0.033	rs104886257	Inc.	6	Dec.	-0.557
rs104886139	Inc.	6	Dec.	-0.274	rs104886261	Inc.	3	Inc.	0.124
rs104886140	Inc.	4	Dec.	-0.212	rs104886263	Inc.	5	Dec.	-0.314
rs104886141	Inc.	4	Dec.	-0.494	rs104886264	Inc.	7	Dec.	-0.292
rs104886142	Inc.	4	Dec.	-0.116	rs104886266	Inc.	4	Dec.	-0.561
rs104886143	Inc.	7	Dec.	-0.622	rs104886267	Dec.	1	Inc.	0.177
rs104886144	Inc.	5	Dec.	-0.332	rs104886269	Inc.	6	Inc.	0.335
rs104886145	Inc.	4	Dec.	-0.201	rs104886272	Inc.	6	Dec.	-0.408

rs104886147	Inc.	3	Dec.	-0.368	rs104886273	Inc.	5	Inc.	0.046
rs104886150	Inc.	2	Dec.	-0.901	rs104886274	Inc.	4	Inc.	0.068
rs104886151	Inc.	4	Dec.	-0.159	rs201220208	Dec.	9	Dec.	-0.982

Inc.: Increase, **Dec.:** Decrease

Modeling SNPs with Project HOPE

Each amino acid has different charge, size, and hydrophobic values. For this reason, amino acid changes due to single-nucleotide polymorphisms create differences in charge, size, and hydrophobicity between wild type and mutant type. Glycine substitutions were observed in a substantial proportion of variants across the three analyzed genes. Detailed structural information for all glycine substitutions could not be fully retrieved using the Project HOPE tool.

Glycine substitutions were frequently observed among the variants consistently predicted to be deleterious in this study. A total of 192 amino acid substitutions were identified, of which 189 (98.4%) involved glycine residues. The remaining substitutions included two cysteine-to-phenylalanine and one proline-to-threonine substitutions.

Since a single rsID can be associated with multiple amino acid substitutions, the total number of amino acid substitutions does not necessarily correspond to the number of unique consensus deleterious SNPs. Therefore, Table 3 summarizes amino acid substitutions rather than unique rsIDs.

The distribution of glycine substitutions across the three analyzed genes is summarized in Table 3.

Table 3. Distribution of glycine substitutions among the identified amino acid substitutions in COL4A3, COL4A4, and COL4A5.

		COL4A3	COL4A4	COL4A5	TOTAL
Glycine	Glutamic Acid	3	2	21	26
Glycine	Aspartic Acid	1	2	32	35
Glycine	Serine	1	0	19	20
Glycine	Arginine	5	6	40	51
Glycine	Cysteine	0	0	10	10
Glycine	Valine	2	2	31	35
Glycine	Alanine	0	1	9	10
Glycine	Tryptophan	0	0	2	2

Discussion

Amino acid substitutions caused by missense SNPs can significantly alter the structural and functional properties of proteins, including charge distribution, hydrophobicity,

stability, and folding³⁴. These changes have the potential to affect protein function and have serious biological repercussions. Substitutions in specific key domains have the potential to interfere with three-dimensional conformation and protein–protein interactions, thereby contributing to disease development³⁵.

The identification of single-nucleotide polymorphisms (SNPs) is crucial for the early diagnosis of hereditary diseases. Early genetic diagnosis of Alport syndrome may enable timely initiation of treatment, which can delay the progression of kidney disease and the onset of kidney failure.

Clinical research suggests that renal deterioration can be effectively attenuated and long-term patient outcomes improved through early diagnosis followed by the timely initiation of angiotensin-converting enzyme inhibitor (ACEI) therapy¹².

Genetic testing is recommended to support the diagnosis of Alport syndrome. In individuals with suspected Alport syndrome, next-generation sequencing (NGS)-based customized gene panels enable the simultaneous analysis of COL4A3, COL4A4, and COL4A5 and facilitate the identification of potentially disease-associated variants.

In silico analyses are particularly valuable for the functional interpretation and prioritization of genetic variants identified through NGS. By predicting the potential functional and structural effects of these variants, in silico tools can help distinguish potentially deleterious variants from those less likely to affect protein function. Therefore, integrating in silico prediction tools with NGS data may facilitate the prioritization of relevant candidate variants for subsequent experimental and clinical evaluation.

In this study, SNPs in the COL4A3, COL4A4, and COL4A5 genes associated with Alport syndrome were comprehensively analyzed using SIFT, PROVEAN, Mutation Assessor, PolyPhen-2, SNAP2, I-Mutant 2.0, MUpro, Project HOPE, and GeneMANIA to evaluate their potential effects on protein function, stability, and structure. This consensus-based approach provides a stringent framework for variant prioritization by selecting only those variants consistently predicted to be deleterious across all in silico prediction tools, thereby increasing confidence in identifying potentially deleterious variants.

In summary, the present study identified the following:

A total of 1125 SNPs were identified for COL4A3. A substantial proportion of SNPs were excluded based on multi-tool consensus analysis. A total of 12 SNPs were consistently predicted to be deleterious across all prediction tools.

A total of 1338 SNPs were identified for COL4A4. A total of 14 SNPs were consistently predicted to be deleterious across all prediction tools.

A total of 1342 SNPs were identified for COL4A5, of which 146 amino acid changes were consistently predicted to be deleterious.

The deleterious SNPs identified in this study were consistent with previously reported case studies³⁶⁻³⁹.

A prominent finding of this study is the high frequency of glycine substitutions among deleterious variants. Collagen is characterized by repeating Gly-X-Y motifs, in which every third amino acid is glycine. This structure enables the formation of a tight triple helix, as glycine's minimal side chain allows the three chains to pack closely together. Mutations affecting glycine residues can disrupt the integrity of the triple helix by delaying folding and reducing structural stability. Such alterations are especially detrimental to type IV collagen, which forms a major component of the glomerular basement membrane, and are known to cause inherited disorders such as Alport syndrome^{40,41}. The following structural interpretations of the identified amino acid substitutions are based on the biochemical properties of the amino acids and previously published experimental evidence, rather than solely on Project HOPE predictions.

According to the analysis results, 26 glycine-glutamic acid and 35 glycine-aspartic acid substitutions were identified. Glycine is neutral, whereas glutamic acid and aspartic acid are negatively charged; therefore, these substitutions may alter local electrostatic interactions and affect protein stability⁴².

20 glycine-serine, 35 glycine-valine, 10 glycine-alanine, and 2 glycine-tryptophan substitutions were identified. These substitutions involve replacement of glycine by amino acids with different side-chain sizes and physicochemical properties and may therefore affect structural flexibility, triple-helix formation, and protein stability^{43,44}.

51 glycine-arginine substitutions were identified. Glycine is neutral, whereas arginine carries a positive charge. This substitution may alter the local electrostatic environment and affect protein structure and interactions⁴⁵.

10 glycine-cysteine substitutions were identified. Cysteine has different physicochemical properties compared with glycine; therefore, glycine-to-cysteine substitutions may lead to functional and structural changes in proteins⁴⁶.

Apart from glycine substitutions, 2 cysteine-to-phenylalanine and 1 proline-to-threonine substitutions were identified. Cysteine residues can contribute to protein stability through disulfide bond formation, whereas proline has a distinctive role in determining local protein conformation. Therefore, substitutions involving these residues may influence local protein structure and stability^{47,48}.

In light of these findings, this study identified potentially deleterious amino acid substitutions associated with SNPs in Alport syndrome-related genes. These findings provide preliminary insights that may contribute to future genetic and experimental studies.

Conclusion

In this study, SNPs in the *COL4A3*, *COL4A4*, and *COL4A5* genes associated with Alport syndrome were evaluated using multiple in silico prediction tools, and variants consistently predicted to be deleterious across all applied tools were identified.

Protein stability analyses did not produce a uniform consensus between I-Mutant 2.0 and MUpro. I-Mutant 2.0 predominantly predicted increased stability, whereas MUpro predominantly predicted decreased stability. Therefore, the direction of the stability changes cannot be conclusively determined based solely on these computational predictions.

Glycine substitutions accounted for 189 of the 192 identified amino acid substitutions (98.4%). Given the structural importance of glycine in collagen, these substitutions may affect protein conformation and proper folding.

Our findings showed that *COL4A5* contained the highest number of potentially deleterious variants. The higher number of deleterious variants identified in *COL4A5* is consistent with the prominent role of *COL4A5* variants in the genetic basis of Alport syndrome reported in the literature⁴⁹.

The identification and prioritization of these variants may provide useful information for future genotyping, genetic screening, and experimental studies. These findings provide a prioritized set of potentially deleterious variants for further genetic, experimental, and clinical evaluation. However, further computational, experimental, and clinical studies are required to validate the actual effects of these variants and determine their potential relevance to genetic screening and disease characterization.

This study was derived from the master's thesis of Beyza R meysa Erginal Ge, entitled 'Analysis of Some Genes Associated with Alport Syndrome Using Bioinformatics Tools', conducted in the Department of Molecular Biology.

REFERENCES

1. Williamson DA. Alport's syndrome of hereditary nephritis with deafness. *Lancet*. 1961;2(7216):1321-1323. doi: 10.1016/S0140-6736(61)90899-6.
2. Gubler MC, Levy M, Broyer M, et al. Alport's syndrome: A report of 58 cases and a review of the literature. *Am J Med*. 1981;71(4):493-505. doi: 10.1016/0002-9343(81)90571-4.
3. Temme J, Peters F, Lange K, et al. Incidence of renal failure and nephroprotection by RAAS inhibition in heterozygous carriers of X-linked and autosomal recessive Alport mutations. *Kidney Int*. 2012;81(8):779-783. doi: 10.1038/ki.2011.452.

4. Gross O, Weber M. From the molecular genetics of Alport's syndrome to principles of organo-protection in chronic renal diseases. *Med Klin (Munich)*. 2005;100(12):826-831.
5. Migeon BR. X inactivation, female mosaicism, and sex differences in renal diseases. *J Am Soc Nephrol*. 2008;19(11):2052-2059. doi: 10.1681/ASN.2008020198.
6. Kashtan CE. Alport syndrome: Achieving early diagnosis and treatment. *Am J Kidney Dis*. 2021;77(2):272-279. doi: 10.1053/j.ajkd.2020.03.026.
7. Izzedine H, Tankere F, Launay-Vacher V, Deray G. Ear and kidney syndromes: Molecular versus clinical approach. *Kidney Int*. 2004;65(4):1290-1302.
8. Shaw EA, Colville D, Wang YY, et al. Characterization of the peripheral retinopathy in X-linked and autosomal recessive Alport syndrome. *Nephrol Dial Transplant*. 2007;22(1):104-108. doi: 10.1093/ndt/gfl607.
9. Byrne MC, Budisavljevic MN, Fan Z, et al. Renal transplant in patients with Alport's syndrome. *Am J Kidney Dis*. 2002;39(4):769-775. doi: 10.1053/ajkd.2002.31997.
10. Perrin D, Jungers P, Grünfeld JP, et al. Perimacular changes in Alport's syndrome. *Am J Ophthalmol*. 1980;90(1):1-7. doi: 10.1016/s0002-9394(14)75069-7.
11. Shah SN, Weinberg DV. Giant macular hole in Alport syndrome. *Ophthalmic Genet*. 2010;31(2):89-91. doi: 10.3109/13816811003767128.
12. Gross O, Licht C, Anders HJ, et al. Early angiotensin-converting enzyme inhibition in Alport syndrome delays renal failure and improves life expectancy. *Kidney Int*. 2012;81(5):494-501. doi: 10.1038/ki.2011.407.
13. GeneCards. COL4A5 gene. GeneCards. <https://www.genecards.org/cgi-bin/carddisp.pl?gene=COL4A5>. Accessed April 27, 2026.
14. GeneCards. COL4A4 gene. GeneCards. <https://www.genecards.org/cgi-bin/carddisp.pl?gene=COL4A4>. Accessed April 27, 2026.
15. GeneCards. COL4A3 gene. GeneCards. <https://www.genecards.org/cgi-bin/carddisp.pl?gene=COL4A3>. Accessed April 27, 2026.
16. Karki R, Pandya D, Elston RC, Ferlini C. Defining “mutation” and “polymorphism” in the era of personal genomics. *BMC Med Genomics*. 2015;8:37. doi:10.1186/s12920-015-0115-z.

17. Ismail S, Essawi M. Genetic polymorphism studies in humans. *Middle East J Med Genet.* 2012;1(2):57-63. doi: 10.1097/01.MXE.0000415225.85003.47.
18. MedlinePlus. What are single nucleotide polymorphisms (SNPs)? MedlinePlus Genetics. <https://medlineplus.gov/genetics/understanding/genomicresearch/snp/>. Accessed April 27, 2026.
19. Lander ES. The new genomics: Global views of biology. *Science.* 1996;274(5287):536-539.
20. Dabhi B, Mistry KN. In silico analysis of SNP in human TNF- α gene. *Meta Gene.* 2014;2:586-595. doi: 10.1016/j.mgene.2014.07.005.
21. Cargill M, Altshuler D, Ireland J, et al. Characterization of SNPs in coding regions of human genes. *Nat Genet.* 1999;22(3):231-238. doi: 10.1038/10290.
22. Rozario LT, Sharker T, Nila TA. In silico analysis of deleterious SNPs of human MTUS1 gene. *PLoS One.* 2021;16(6):e0252932. doi: 10.1371/journal.pone.0252932.
23. Mah JT, Low ES, Lee E. In silico SNP analysis and bioinformatics tools. *Drug Discov Today.* 2011;16(17-18):800-809. doi: 10.1016/j.drudis.2011.07.005.
24. The UniProt Consortium. UniProt: The universal protein knowledgebase in 2021. *Nucleic Acids Res.* 2021;49(D1):D480-D489. doi:10.1093/nar/gkaa1100.
25. Kumar P, Henikoff S, Ng PC. Predicting the effects of coding non-synonymous variants on protein function using the SIFT algorithm. *Nat Protoc.* 2009;4(7):1073-1081. doi: 10.1038/nprot.2009.86.
26. Ng PC, Henikoff S. Predicting the effects of amino acid substitutions on protein function. *Annu Rev Genomics Hum Genet.* 2006;7:61-80. doi: 10.1146/annurev.genom.7.080505.115630.
27. Adzhubei IA, Schmidt S, Peshkin L, et al. A method and server for predicting damaging missense mutations. *Nat Methods.* 2010;7(4):248-249. doi: 10.1038/nmeth0410-248.
28. Choi Y, Chan AP. PROVEAN web server: A tool to predict the functional effect of amino acid substitutions and indels. *Bioinformatics.* 2015;31(16):2745-2747. doi: 10.1093/bioinformatics/btv195.
29. Hecht M, Bromberg Y, Rost B. Better prediction of functional effects for sequence variants. *BMC Genomics.* 2015;16(Suppl 8):S1. doi: 10.1186/1471-2164-16-S8-S1.

30. Capriotti E, Fariselli P, Casadio R. I-Mutant2.0: Predicting stability changes upon mutation from the protein sequence or structure. *Nucleic Acids Res.* 2005;33(Web Server issue):W306-W310. doi: 10.1093/nar/gki375.
31. Cheng J, Randall A, Baldi P. Prediction of protein stability changes for single-site mutations using support vector machines. *Proteins.* 2006;62(4):1125-1132. doi: 10.1002/prot.20810.
32. Venselaar H, Te Beek TA, Kuipers RK, Hekkelman ML, Vriend G. Protein structure analysis of mutations causing inheritable diseases. An e-Science approach with life scientist friendly interfaces. *BMC Bioinformatics.* 2010;11:548. doi: 10.1186/1471-2105-11-548.
33. Warde-Farley D, Donaldson SL, Comes O, et al. The GeneMANIA prediction server: Biological network integration for gene prioritization and predicting gene function. *Nucleic Acids Res.* 2010;38(Web Server issue):W214-W220. doi: 10.1093/nar/gkq537.
34. Wang Z, Moult J. SNPs, protein structure, and disease. *Hum Mutat.* 2001;17(4):263-270.
35. Yue P, Li Z, Moult J. Loss of protein structure stability in disease. *J Mol Biol.* 2005;353(2):459-473. doi: 10.1016/j.jmb.2005.08.020.
36. Zhou J, Hertz JM, Tryggvason K. Mutation in COL4A5 chain in Alport syndrome. *Am J Hum Genet.* 1992;50(6):1291-1300.
37. Knebelmann B, Deschenes G, Gros F, et al. Substitution of arginine for glycine 325 in COL4A5. *Am J Hum Genet.* 1992;51(1):135-142.
38. Renieri A, Seri M, Myers JC, et al. De novo mutation in COL4A5 gene. *Hum Mol Genet.* 1992;1(2):127-129. doi: 10.1093/hmg/1.2.127.
39. Choi M, Anistan YM, Eckardt KU, Gollasch M, Nickel P. Possible digenic disease in COL4A3 and COL4A5. *Nephron.* 2019;141(3):213-218. doi: 10.1159/000495764.
40. Kashtan CE, Fish AJ, Kleppel M, Yoshioka K, Michael AF. Nephritogenic antigens in Alport syndrome. *J Clin Invest.* 1986;78(4):1035-1044. doi: 10.1172/JCI112658.
41. Hudson BG, Tryggvason K, Sundaramoorthy M, Neilson EG. Alport's syndrome and type IV collagen. *N Engl J Med.* 2003;348(25):2543-2556. doi: 10.1056/NEJMra022296.
42. Kuivaniemi H, Tromp G. Type III collagen: Structure and diseases. *Gene.* 2019;707:151-171. doi: 10.1016/j.gene.2019.05.003.

43. Shboul M, Sassi H, Jilani H, et al. Glycine to serine mutation in COL2A1 gene. *AIMS Mol Sci.* 2021;8(1):76-85. doi: 10.3934/molsci.2021004.
44. Nuytinck L, Tükel T, Kayserili H, Apak MY, De Paepe A. Glycine to tryptophan substitution in collagen. *J Med Genet.* 2000;37(5):371-375. doi: 10.1136/jmg.37.5.371.
45. Molnár J, Szakács G, Tusnády GE. Disease-associated mutations in transmembrane proteins. *PLoS One.* 2016;11(3):e0151760. doi: 10.1371/journal.pone.0151760.
46. Wilcox W, Scott L, Cohn D. An N-terminal glycine to cysteine mutation in the collagen COL1A1 gene produces moderately severe osteogenesis imperfecta. *Am J Hum Genet.* 1994;55(suppl 3).
47. MacArthur MW, Thornton JM. Influence of proline residues on protein conformation. *J Mol Biol.* 1991;218(2):397-412. doi: 10.1016/0022-2836(91)90721-H.
48. Creighton TE. Disulphide bonds and protein stability. *BioEssays.* 1988;8(2-3):57-63. doi: 10.1002/bies.950080204.
49. Yavas C, Ozdemir Ozgenturk N, Dogan M, et al. A deeper insight into COL4A3, COL4A4, and COL4A5 variants and genotype-phenotype correlation of a Turkish cohort with Alport syndrome. *Mol Syndromol.* 2024;15(1):1-13. doi: 10.1159/000533915.

Telemedicine Research Trends: A Bibliometric Perspective on Security and Privacy

Binnur AKIF*, Nesrin KOLUKIRIK**, Sinem BÜYÜKSAATÇI KİRİŞ***

Abstract

Aim: To explore the intersection of telemedicine, security and privacy through a comprehensive bibliometric analysis, with a focus on technological developments, thematic structures, and global research trends.

Method: This study is a bibliometric analysis examining publication trends, thematic structures, keyword patterns and authorial, institutional and County-level contributions to telemedicine security research. A total of 10,641 peer-reviewed articles were retrieved from scientific databases covering health services, telemedicine and information technology literature from 2014 to April 2026. Co-occurrence analysis and thematic mapping were used to identify foundational, specialized, driving and emerging areas of inquiry. Bibliometric tools were used to analyze scientific production, collaboration patterns, keyword structures and thematic development.

Results: The volume of research increased significantly after 2020, reflecting the growing role of telemedicine and digital health services during and after the COVID-19 pandemic. The findings show that “telemedicine,” “privacy,” “security,” “digital health,” “mHealth,” and “telehealth” are among the most frequent and influential keywords in the field. The thematic map indicates that security, privacy and blockchain appear as specialized niche themes, whereas artificial intelligence, machine learning, deep learning, big data, and ethics represent emerging areas requiring stronger integration with telemedicine security and privacy research. The results also reveal broad contributions from various authors, institutions, journals, and countries, confirming the multidisciplinary and global nature of this research area.

Conclusion: Research on telemedicine security is rapidly expanding, with increasing attention to digital health infrastructures, privacy protection, cybersecurity, and patient-centered remote care. Future studies should focus on integrating security and privacy mechanisms into mainstream telemedicine applications, developing secure data-sharing frameworks, strengthening ethical and privacy-preserving AI-based telemedicine systems and addressing user acceptance differences related to sociocultural, regional, and Digital literacy. These directions can support the development of safer, more trustworthy, inclusive, and sustainable digital health systems.

Keywords: Telemedicine, security, e-health, data privacy, bibliometric analysis.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 01.10.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1794018>

* Asst. Prof., Istanbul Gelisim University, Faculty of Engineering and Architecture, Department of Industrial Engineering, Istanbul, Türkiye. E-mail: bgurul@gelisim.edu.tr [ORCID https://orcid.org/0000-0001-8708-702X](https://orcid.org/0000-0001-8708-702X)

** Res. Asst., National Defense University, Air Force Academy, Department of Industrial Engineering, Istanbul, Türkiye. E-mail: nesrin.kolukirik@msu.edu.tr [ORCID https://orcid.org/0000-0001-7299-7020](https://orcid.org/0000-0001-7299-7020)

*** Asst. Prof., Istanbul University-Cerrahpaşa, Faculty of Engineering, Department of Industrial Engineering, Istanbul, Türkiye. E-mail: s.buyuksaatcikiris@iuc.edu.tr [ORCID https://orcid.org/0000-0001-7697-3018](https://orcid.org/0000-0001-7697-3018)

Tele-tıp Araştırma Trendleri: Güvenlik ve Gizlilik Üzerine Bibliyometrik Bir Bakış Açısı

Öz

Amaç: Teknolojik gelişmeler, tematik yapılar ve küresel araştırma trendlerine odaklanarak, kapsamlı bir bibliyometrik analiz yoluyla tele-tıp, güvenlik ve gizlilik kesişimini incelemektir.

Yöntem: Bu çalışma; tele-tıp güvenliği araştırmalarındaki yayın eğilimlerini, tematik yapıları, anahtar kelime kalıplarını ve yazar, kurum ve ülke düzeyindeki katkıları inceleyen bir bibliyometrik analizdir. Sağlık hizmetleri, tele-tıp ve bilgi teknolojisi literatürünü kapsayan bilimsel veri tabanlarından 2014 ile Nisan 2026 tarihleri arasında yayınlanmış toplam 10.641 hakemli makale elde edilmiştir. Çalışmada; temel, uzmanlaşmış, yönlendirici ve gelişmekte olan araştırma alanlarını belirlemek için eş zamanlılık analizi ve tematik haritalama kullanılmıştır. Bilimsel üretim, işbirliği kalıpları, anahtar kelime yapıları ve tematik gelişmeyi analiz etmek için bibliyometrik araçlardan yararlanılmıştır.

Bulgular: 2020'den sonra araştırma hacmi önemli ölçüde artmış olup, bu durum COVID-19 pandemisi sırasında ve sonrasında teletıp ve dijital sağlık hizmetlerinin artan rolünü yansıtmaktadır. Bulgular, “teletıp,” “gizlilik,” “güvenlik,” “dijital sağlık,” “mHealth” ve “tele sağlık” kelimelerinin alandaki en sık ve etkili anahtar kelimeler arasında olduğunu göstermektedir. Tematik harita, güvenlik, gizlilik ve blok zincirinin uzmanlaşmış niş temalar olarak ortaya çıktığını, yapay zeka, makine öğrenimi, derin öğrenme, büyük veri ve etişin ise teletıp güvenliği ve gizlilik araştırmalarıyla daha güçlü entegrasyon gerektiren gelişmekte olan alanları temsil ettiğini göstermektedir. Sonuçlar ayrıca, çeşitli yazarların, kurumların, dergilerin ve ülkelerin geniş katkılarını ortaya koyarak, bu araştırma alanının çok disiplinli ve küresel doğasını doğrulamaktadır.

Sonuç: Tele-tıp güvenliği araştırmaları, dijital sağlık altyapılarına, gizlilik korumasına, siber güvenliğe ve hasta merkezli uzaktan bakıma artan ilgiyle birlikte hızla genişlemektedir. Gelecekteki çalışmalar; güvenlik ve gizlilik mekanizmalarını ana akım teletıp uygulamalarına entegre etmeye, güvenli veri paylaşım çerçeveleri geliştirmeye, etik ve gizliliği koruyan yapay zeka tabanlı teletıp sistemlerini güçlendirmeye ve kullanıcı kabulünde sosyokültürel, bölgesel ve dijital okuryazarlıkla ilgili farklılıkları ele almaya odaklanmalıdır. Bu yönlendirmeler, daha güvenli, daha güvenilir, kapsayıcı ve sürdürülebilir dijital sağlık sistemlerinin geliştirilmesini destekleyebilir.

Anahtar Sözcükler: Tele-tıp, güvenlik, e-sağlık, veri gizliliği, bibliyometrik analiz.

Introduction

Telemedicine refers to the delivery of healthcare services through telecommunications and electronic information technologies. It covers a set of applications that enable the remote delivery of medical services between patients and healthcare professionals. This technology offers several advantages for both patients and healthcare professionals. Rising healthcare costs and the increasing demand for high-quality care are encouraging healthcare organizations to adopt and expand telemedicine services¹.

Telemedicine has emerged as a critical approach to increasing access to healthcare, especially in remote or underserved areas. By enhancing geographic accessibility, health inequalities can be significantly reduced by providing access to basic medical services for individuals living in rural or underserved areas. To expand access to telemedicine for underserved patients, healthcare providers must develop strategies that promote engagement and ensure equitable access to essential telemedicine services. Additionally, addressing challenges such as digital literacy, provision of necessary equipment and

communication tools, as well as regulatory and legal barriers, is essential to ensure equitable and inclusive access to telemedicine for all individuals².

According to United Nations data, 76% of hospitals use telemedicine technologies to connect with patients. Among the medical specialties, teleradiology (39.5%), emergency medicine (38.9%), pathology (30.4%) and psychiatry (27.8%) demonstrate the highest levels of telemedicine adoption. In addition, telemedicine is widely applied in cardiology, dermatology, oncology, and both pre- and post-surgical care. Globally, the purposes of telemedicine use vary by region. In Japan, healthcare providers use telemedicine as a complementary tool to face-to-face meetings. In South Korea, it is used for post-examination follow-ups. Across the European Union, telemedicine is widely utilized to monitor patients with chronic diseases. In the United States, telemedicine is broadly integrated into hospitals and clinics, including prescription determination and treatment decision-making³.

Despite offering such great conveniences and benefits, telemedicine still faces various technological, regulatory, and financial barriers. The primary barriers for patients include adaptation to new technology, lack of face-to-face interaction, communication difficulties, and security concerns. Significant barriers from the perspective of healthcare providers include inadequate infrastructure, high costs, and legal uncertainties. These barriers can be categorized into two main categories: internal and external barriers. Internal barriers are directly related to patients' personal perceptions, experiences, and technological skills⁴⁻⁶. External barriers arise from broader issues, such as technological infrastructure, financial planning, data security, and regulatory framework^{4,6-8}. Among these, data security remains the most pressing concern.

The secure sharing of patient information is a major requirement in telemedicine. Traditional centralized systems typically store data in a central cloud infrastructure. These data include highly sensitive medical images and health records. Numerous studies have highlighted that patient data collection and processing may lead to significant privacy and security risks⁹. Data privacy in telemedicine refers to the protection of sensitive patient information exchanged during remote healthcare services. This encompasses ensuring confidentiality, integrity and secure transmission of medical data. Confidentiality ensures that patient information is only accessible to authorized individuals, such as healthcare providers, and prevents unauthorized access or sharing^{10,11}. Data integrity protects medical data from unauthorized modifications, which could lead to misdiagnosis or incorrect treatment¹¹. Secure data transmission involves the transmission of large volumes of sensitive data over public networks¹². To address these, improvements in IT security together with enhanced measures for data privacy and cybersecurity, are essential for maintaining trust, ensuring effective healthcare delivery, and protecting against evolving cybersecurity threats. A multi-layered security strategy encompassing IoT devices, communication networks, and hospital information systems has been proposed¹³⁻¹⁵. The proposed strategy includes key components such as authentication, access control and Data Loss Prevention (DLP) solutions.

Authentication is the process of verifying the identity of a user, device, or system to ensure they are who they claim to be^{16,17}. It establishes trust between the user and the system and ensures that only legitimate users or devices can access the telemedicine system¹⁸. Passwords, tokens, and biometric features (e.g., fingerprints, facial recognition)¹⁷, advanced methods such as single sign-on (SSO)¹⁹ or cryptographic protocols (e.g., elliptic curve cryptography)²⁰ are some techniques to verify a patient's or doctor's identity. Access control determines what authenticated users are allowed to do within the system^{16,17}. It enforces rules about who can access specific resources and what actions they can perform²¹. Role-based access control and consent-driven data sharing frameworks enhance privacy by allowing patients to control who accesses their data²². Blockchain-based systems and encryption protocols, such as Attribute-Based Encryption (ABE), provide fine-grained access control, ensuring that only authorized users can access sensitive data²³. Granting specific privileges to authenticated users by cryptographic tokens (e.g., Security Access Tokens) is another restricting mechanism²⁴.

Cybersecurity in telemedicine refers to the measures and practices implemented to protect sensitive medical data, ensure the secure operation of telemedicine platforms, and safeguard patient privacy in a digital healthcare environment. Telemedicine relies heavily on interconnected technologies, including the Internet of Medical Things (IoMT), cloud computing, and artificial intelligence, to facilitate remote consultations, diagnostics, and treatment services. This reliance introduces significant cybersecurity challenges, including data breaches, ransomware attacks, insider threats, and vulnerabilities in medical devices, which can disrupt healthcare services and compromise patient safety²⁵⁻²⁷. Breaches can lead to identity theft, unauthorized access, and misuse of personal health information²⁸.

In recent years, the intersection of telemedicine and cybersecurity has attracted increasing scholarly attention, driven by the rapid digitalization of healthcare and the escalating challenges of data privacy and system integrity. Against this backdrop, this study conducts a bibliometric analysis to systematically examine research at the intersection of telemedicine and security. By identifying key research trends, influential contributors, and thematic developments, the study aims to provide a comprehensive perspective on how telemedicine technologies have evolved and where future research opportunities lie.

This study is structured into four main sections. Following the introduction, the methodology section explains the bibliometric analysis approach. The results and discussion section presents key findings, including publication trends, prominent authors and institutions, thematic developments, and keyword patterns. Finally, the conclusion summarizes the main insights and outlines potential directions for future research.

Material and Methods

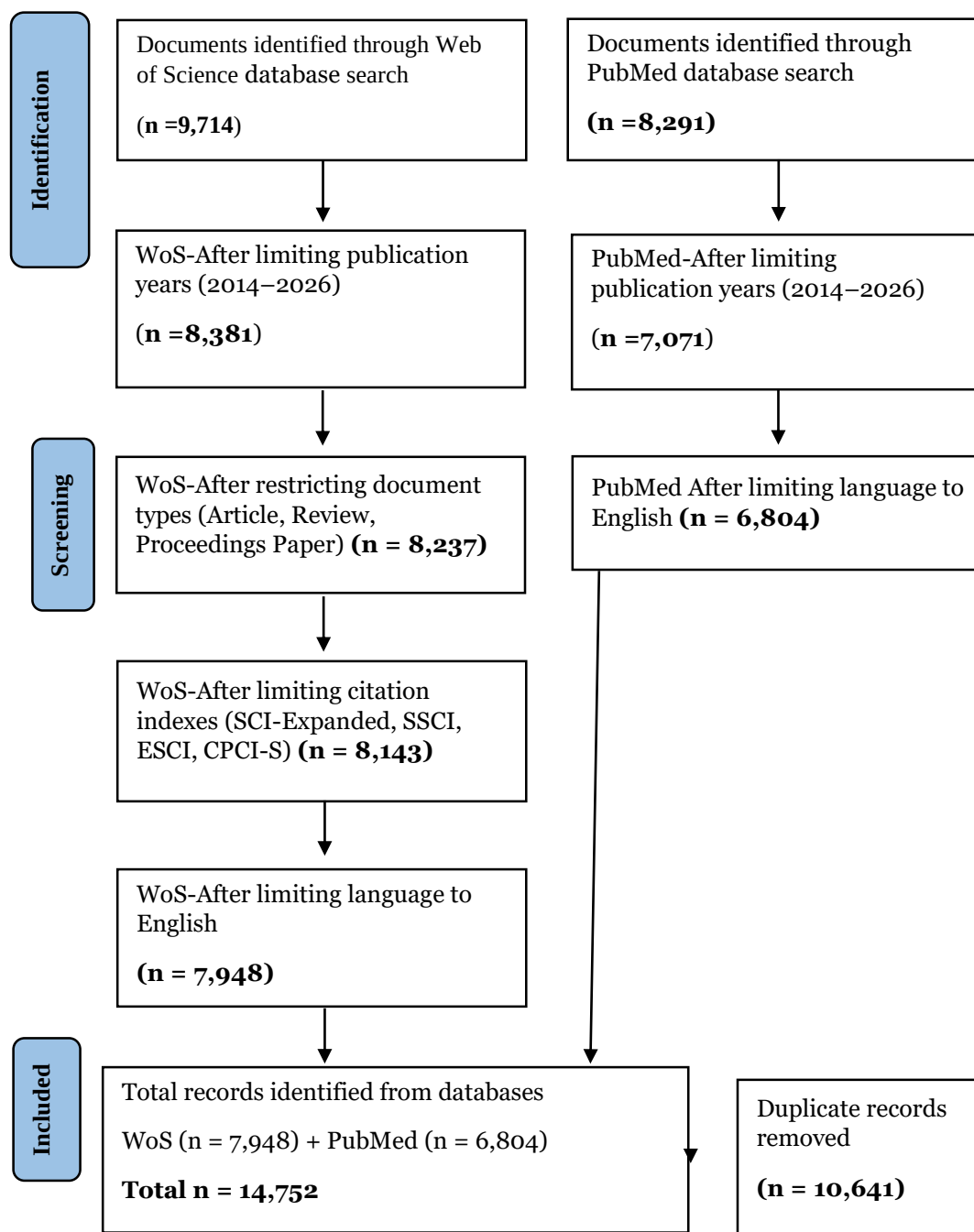
Bibliometric analysis, which emerged as an alternative to meta-analysis and systematic literature reviews, has become a widely used method for examining scientific literature²⁹.

This analysis is used as a descriptive method to organize, measure, and evaluate the impact and contributions of research on a particular topic within a certain period of time. Additionally, it evaluates the performance of authors, institutions, and countries by using different metrics³⁰. Techniques such as co-word analysis, theme mapping, and citation analysis are commonly employed in bibliometric analysis to identify new trends and/or areas of declining interest. Because of these aspects, bibliometric analysis stands out as a powerful tool for identifying both existing patterns in data and potential future research trends³¹.

The bibliometric analysis presented in this study aims to investigate the relationship between telemedicine and security while also identifying future research opportunities in this domain. A comprehensive search was conducted in the Topic section of the Web of Science (WoS) Core Collection database and Title/Abstract section of the PubMed database to achieve this objective. The following keywords were used to construct the search query: (“telemedicine” OR “telehealth” OR “tele-medicine” OR “tele-health” OR “mHealth” OR “m-health” OR “eHealth” OR “e-health” OR “digital health” OR “remote patient monitoring” OR “teleconsultation” OR “telemonitoring”) AND (“security” OR “cybersecurity” OR “cyber security” OR “data privacy” OR “data protection” OR “information security” OR “privacy” OR “confidentiality” OR “authentication” OR “encryption” OR “blockchain”) AND (“health” OR “healthcare” OR “clinical” OR “patient” OR “medical”).

Figure 1 presents the systematic stages of the search process.

Figure 1. PRISMA diagram.



Results

The bibliometric data were analyzed using Biblioshiny, a web-based interface of the Bibliometrix R package³². Biblioshiny was used to perform descriptive bibliometric analyses, including annual scientific production, most relevant sources, institutional

productivity, country-level scientific production, corresponding author country analysis, keyword frequency analysis, word cloud visualization, and thematic mapping. The use of Biblioshiny enabled systematic visualization and interpretation of publication trends, collaboration patterns, and thematic structures within the dataset.

Data Analysis

Table 1 summarizes the key descriptive metrics related to the final selected dataset. The basic information for the dataset reveals that 10,641 publications/documents (e.g., articles, conference papers) published between 2014 and 2026 appeared in 3,594 different sources. The annual growth rate of publications on the topic was calculated as 72.91%, indicating a rapidly expanding body of literature. Although this value appears relatively high, it should be interpreted cautiously. The high growth rate is largely attributable to the very low number of publications in the early years of the dataset and the substantial increase in publication output after 2020, when telemedicine and digital health research expanded rapidly during and after the COVID-19 pandemic. Therefore, this value does not necessarily indicate a stable year-by-year increase across the entire period but rather reflects the overall expansion of the field from a low initial baseline. The average age of the documents is 4.15, suggesting that the topic is highly recent and continues to attract increasing scholarly attention.

A total of 15,856 author-provided keywords were identified, reflecting a high level of conceptual diversity and a wide range of research perspectives. However, information regarding the total number of references in the dataset was unavailable.

There are 43,604 authors' contributions to the dataset. Only 494 documents were written by a single author, whereas the vast majority were co-authored by multiple researchers. The average number of co-authors per document was 5.94, and the international collaboration rate was 30.52%, highlighting the strong global academic engagement in this research area. The average number of citations per document was 13.93, indicating a considerable level of academic interest and impact.

Table 1. Main Information About the Data.

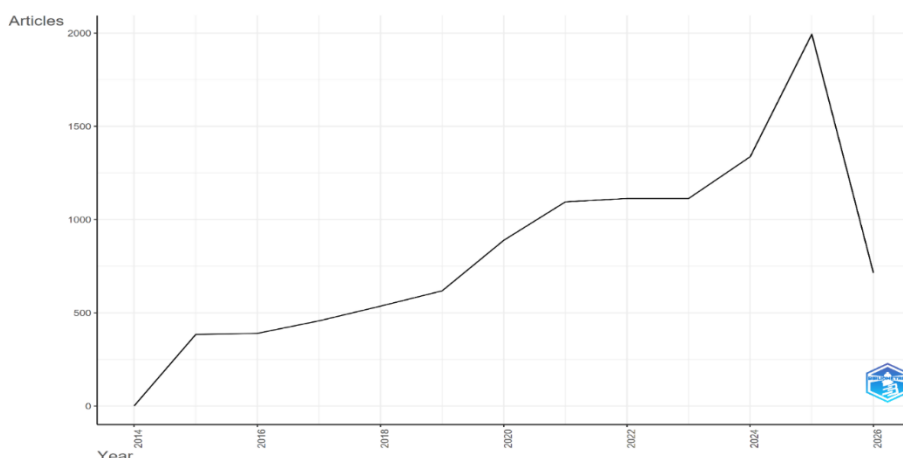
DESCRIPTION	RESULTS
Timespan	From 2014 to April 2026
Sources (Journals, Books, etc.)	3,594
Documents	10,641
Annual Growth Rate (%)	72.91
Document Average Age	4.15
Average citations per doc.	13.93

<i>Authors</i>	
Authors	43,604
Authors of single-authored docs.	494
<i>Authors Collaboration</i>	
Co-Authors per Doc	5.94
International co-authorships (%)	30.52

Annual Scientific Production

Figure 2 shows the scientific productivity in the field from 2014 to first week of April 2026. The graph shows that publication activity remained relatively limited until 2018, followed by a sharp increase after 2019. This pattern indicates that the topic gained considerable academic attention, particularly in the post-pandemic period.

Figure 2. Distribution of Scientific Publications Over Time



The publication trend can be evaluated in three main periods:

1st Period (2014-2018) – Low and Fluctuating Publication Activity: The number of publications remains quite low during this period. Although minor fluctuations were observed, the overall level of scientific production was limited. This suggests that the intersection of telemedicine and data security had not yet become a major research focus during the early years of the dataset.

2nd Period (2019-2021) – Gradual Increase: A noticeable increase in publication output began around 2019 and became more pronounced in 2020 and 2021. This growth can be associated with the rapid expansion of telemedicine and digital health services during the COVID-19 pandemic. The pandemic accelerated the adoption of remote

healthcare delivery systems, which in turn increased scholarly attention to issues such as data privacy, cybersecurity, secure communication, patient information protection, and digital health infrastructure.

3rd Period (2022-2026) – High Publication Volume with Fluctuations: From 2022 onward, the number of publications remained at a considerably high level compared with the earlier years. The figure shows fluctuations across these years, with publication counts reaching peak levels around 2024 and remaining strong in 2025. The decline observed in 2026 should be interpreted cautiously, as the dataset includes publications only until April 2026. Therefore, the lower value for 2026 does not necessarily indicate a real decrease in academic interest, but rather reflects the incomplete coverage of the publication year.

Most Relevant Sources

Table 2 presents the top ten sources in the field. The most prominent source is “Journal of Medical Internet Research” with 416 articles. This journal is one of the leading digital health journals. The journal focuses on areas such as digital health interventions (apps, wearables, platforms), telehealth and telemedicine, mHealth (mobile health), and eHealth systems. Given that the current bibliometric analysis explores telemedicine, the prominence of this journal is highly meaningful.

“Digital Health” ranks second with 300 publications. This journal covers a broad range of digital health technologies and interventions, making it a relevant resource for research at the intersection of telemedicine and emerging digital health solutions.

Table 2. Top 10 Most Relevant Resources

#	<i>Name of Journal</i>	<i>Number of Publications</i>	<i>Journal Impact Factor (Reference Year)</i>
1	Journal of Medical Internet Research	416	6.0 (JCR 2025 Release)
2	Digital Health	300	3.3 (JCR 2024 Release)
3	JMIR mHealth and uHealth	265	6.2 (JCR 2025 Release)
4	JMIR Formative Research	181	2.1 (JCR 2025 Release)
5	Studies in Health Technology and Informatics	156	N/A
6	IEEE Access	154	3.6 (JCR 2024 Release)
7	BMC Health Services Research	143	3.0 (JCR 2024 Release)
8	Journal of Medical Systems	114	5.7 (JCR 2024 Release)

#	<i>Name of Journal</i>	<i>Number of Publications</i>	<i>Journal Impact Factor (Reference Year)</i>
9	Frontiers in Digital Health	98	3.8 (JCR 2025 Release)
10	Scientific Reports	97	3.9 (JCR 2024 Release)

* JCR: Journal Citation Reports

Most Relevant Institutions

Table 3 presents the top 10 institutions based on the number of publications. The University of Toronto leads with 368 publications, followed by the University of Washington (322 publications) and Imperial College London (315 publications). The listed institutions come from diverse geographical regions, including the United States, Canada, the United Kingdom, Australia and Saudi Arabia, reflecting the global interest in the topic.

Table 3. Top 10 Most Relevant Institutions

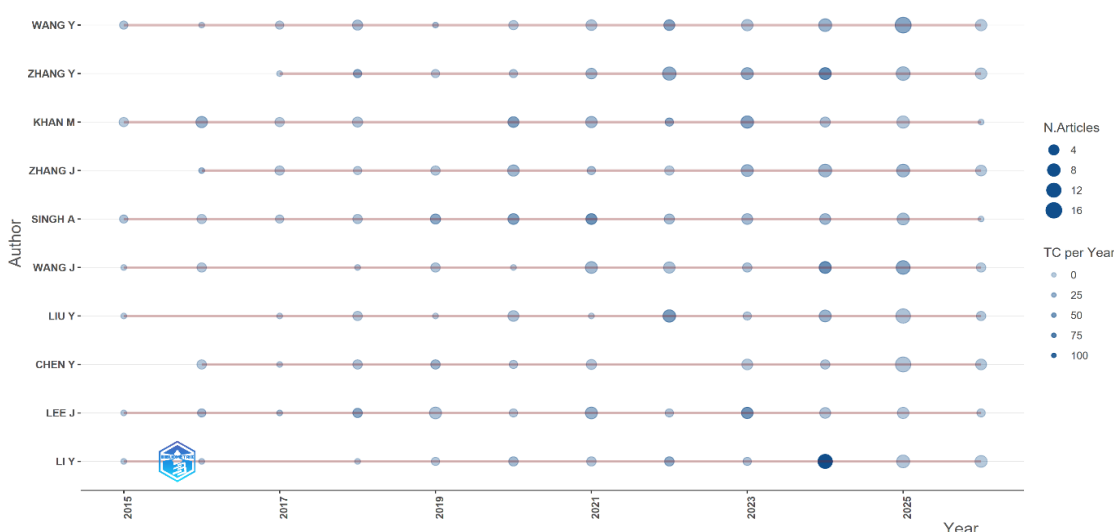
#	<i>Name of Institution</i>	<i>Number of Publications</i>
1	University of Toronto	368
2	University of Washington	322
3	Imperial College London	315
4	University of California San Francisco	163
5	University of Oxford	154
6	Icahn School of Medicine at Mount Sinai	153
7	University of Queensland	145
8	King Saud University	141
9	University of British Columbia	132
10	Harvard Medical School	125

Production Over Time

To evaluate authors' productivity, it is important to consider the time span of their scholarly contributions. Long-term involvement reflects specialization and may indicate higher quality of publication. Figure 3 shows the annual publication activity of top authors using dots, where larger dots represent more publications and darker shading

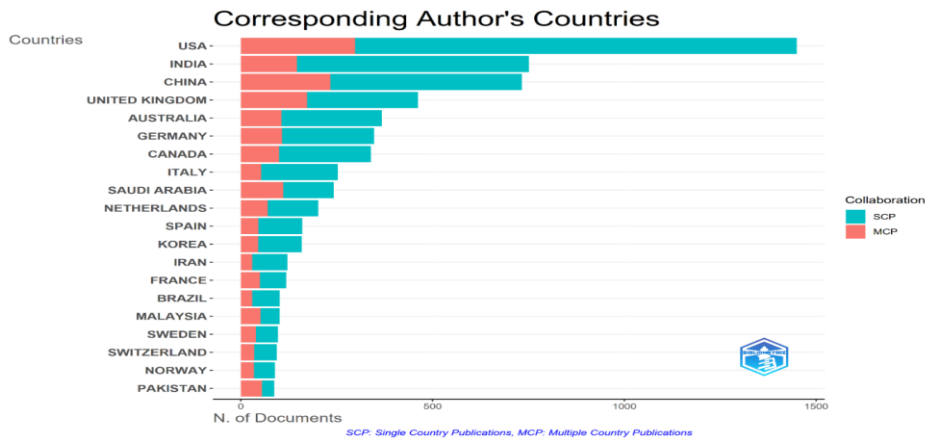
indicates higher citation impact per year. Wang Y. emerged as the most prolific author, with notably large dots in 2023 and 2024, suggesting both sustained contribution and recent peak productivity. Zhang Y., Khan M. and Zhang J. have maintained consistent presence across multiple years, indicating long-term engagement with the field. Singh A., Wang J. and Liu Y. show more concentrated activity, particularly after 2019. Li Y. stands out with an exceptionally high citation impact in 2024, represented by the darkest dot in the figure, despite a relatively moderate publication count. The prevalence of activity after 2019 across most authors suggests that the field attracted intensified scholarly attention in the post-pandemic period, reflecting the growing global emphasis on telemedicine and digital health security.

Figure 3. Productivity of the authors over time.



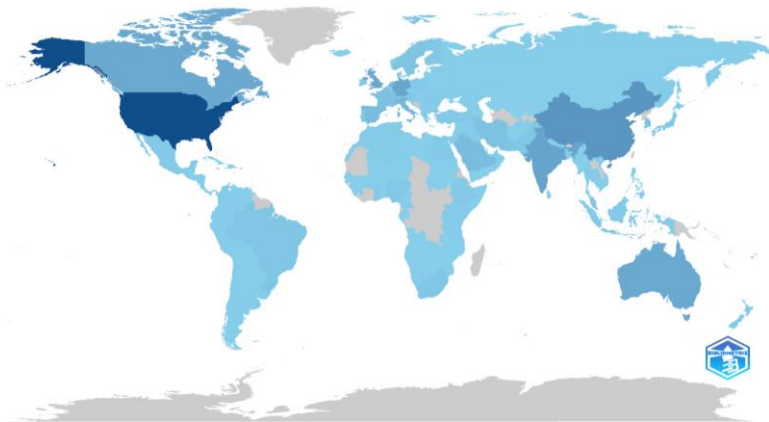
Corresponding Author's Countries

This analysis categorizes corresponding authors based on the type of collaboration. Multi-Country Publications (MCPs) refer to publications produced through international co-authorship, while Single-Country Publications (SCPs) represent studies authored by researchers from the same country, indicating national collaboration. Figure 4 illustrates the MCP-SCP analysis. The United States ranks first in total publication output, with the majority of its publications classified as SCPs, indicating a strong domestic research base. India and China follow the USA and are similarly dominated by national collaborations (SCP). The United Kingdom, Australia, Germany, and Canada also make notable contributions, although their publication volumes are lower than those of the three leading countries. SCPs constitute the larger share of publications in most countries, suggesting that national-level collaboration remains dominant in this research field. However, the presence of internationally co-authored papers highlights the global relevance of telemedicine, digital health and data security research.

Figure 4. Corresponding author's countries.

Scientific Production by Country

A world map with color-coded density is presented in Figure 5 to visualize country-level scientific productivity. Dark blue (e.g., the USA) represents the highest level of research output in the field. U.S. institutions lead health informatics and telehealth research. In lighter blue, China, India, and Australia also serve as major hubs. India, in particular, is increasing its efforts with its extensive healthcare system and technology investments. The map clearly indicates that global scientific production is predominantly concentrated in a limited number of countries. However, the presence of lighter blue regions suggests considerable potential for future collaboration with researchers in those underrepresented areas. Countries such as the United Kingdom, Germany, and France could serve as valuable partners for international studies. The rising publication activity in Saudi Arabia, Iran, and the United Arab Emirates reflects the growing investments in telehealth and AI-supported health solutions, while South America, most of Africa, and parts of Southeast Asia show lower output. These underrepresented areas present opportunities for joint projects and funded research.

Figure 5. Countries' scientific production.

Word Cloud Analysis

Word cloud analysis is a visual tool used to reflect the frequency of keyword usage. In this visualization, the most frequently used keywords appear in larger font sizes, while the less common ones are shown to be smaller. Randomly assigned colors enhance visual appeal.

Figure 6. Word cloud.



The updated keyword analysis reveals that “telemedicine” (1996 occurrences) is the most dominant term in the literature, confirming its central role in the field. This is followed by “humans” (1720 occurrences), highlighting the strong human-centered focus of telemedicine research. Other prominent terms include “privacy” (1163 occurrences), “security” (973 occurrences), and “digital health” (972 occurrences), all of which collectively indicate the growing importance of data protection and cybersecurity in digital healthcare systems.

Additionally, “mhealth” (848 occurrences), “care” (832 occurrences), “telehealth” (792 occurrences), and “health” (754 occurrences) represent key thematic areas related to healthcare delivery and mobile health technologies. The high frequency of “privacy” and “security” further emphasizes that safeguarding patient data and ensuring secure communication infrastructures are critical concerns in telemedicine applications.

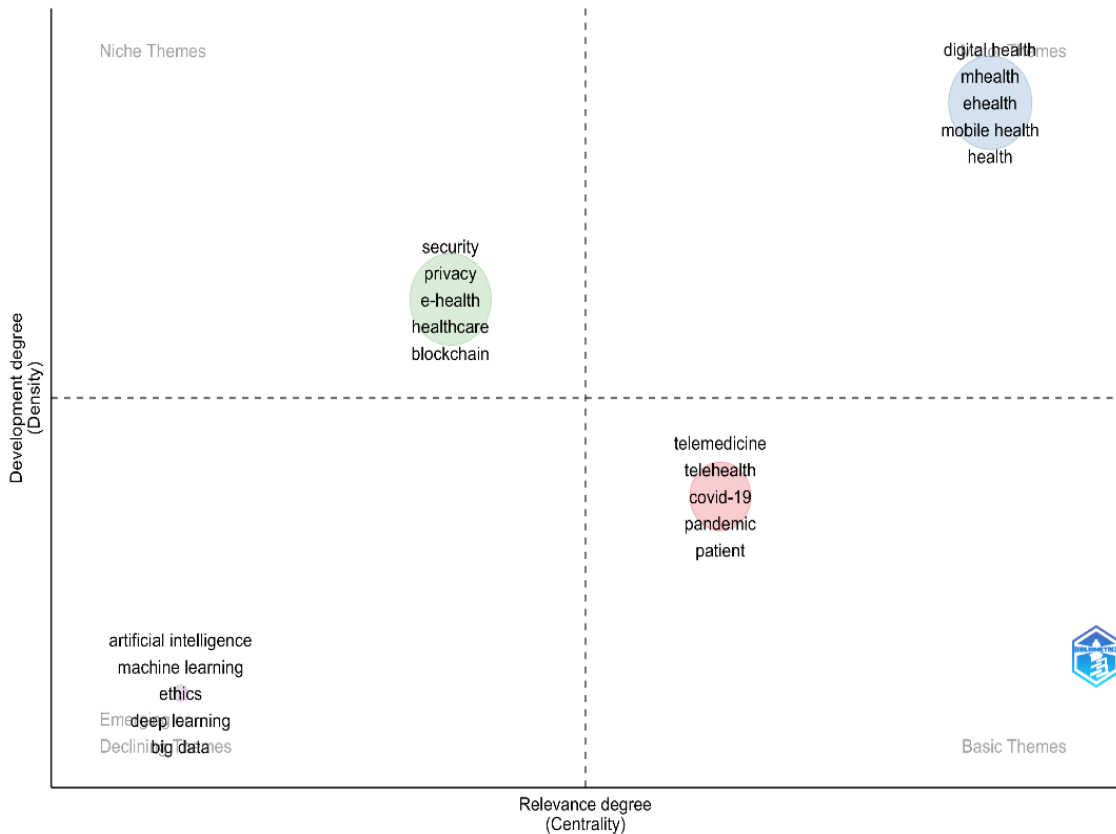
Overall, the distribution of keywords demonstrates that while telemedicine remains the core research domain, there is a significant and increasing integration of digital technologies, human-centered approaches, and cybersecurity considerations within the literature.

Thematic Map

The thematic map presented in Figure 7 is a two-dimensional visualization that illustrates the centrality and level of development of key themes within the research domain. The x-axis represents the degree of centrality, indicating how strongly a theme

links to others, whereas the y-axis reflects the density, indicating its level of development. Themes with high density values are well-developed and are frequently explored in academic studies.

Figure 7. Thematic map.



The thematic map's upper-right quadrant, corresponding to Motor Themes, includes highly central and well-developed themes such as “digital health,” “mHealth,” “eHealth,” “mobile health,” and “health”. The location of this cluster indicates that digital and mobile health technologies constitute one of the most mature and influential research streams within the telemedicine-related literature. These themes are not only strongly developed internally but also highly connected with other thematic areas, suggesting that they play a driving role in shaping the broader research field. The prominence of this cluster reflects the increasing integration of mobile platforms, electronic health systems and digital healthcare infrastructures into contemporary telemedicine practices.

The upper-left quadrant, representing Niche Themes, includes terms such as “security,” “privacy,” “e-health,” “healthcare,” and “blockchain.” These themes exhibit a relatively high level of internal development but lower centrality compared with the motor themes. This position suggests that security and privacy-oriented studies form a specialized and technically developed subfield within the broader telemedicine literature. In particular, the presence of “blockchain” in this quadrant indicates that blockchain-based approaches have gained scholarly attention as potential solutions for secure data sharing,

privacy preservation, and decentralized health information management. However, the limited centrality of this cluster also suggests that these topics have not yet become fully integrated into the mainstream telemedicine research agenda.

The lower-right quadrant, corresponding to Basic Themes, contains terms such as “telemedicine,” “telehealth,” “COVID-19,” “pandemic,” and “patient.” These themes are highly relevant to the overall structure of the field, but their lower density indicates that they are relatively less developed as cohesive thematic clusters. The position of this cluster shows that telemedicine and telehealth serve as foundational concepts in the literature, particularly in relation to patient care and the rapid expansion of remote healthcare services during the COVID-19 pandemic. Although these themes are central to the field, their relatively lower development suggests that further theoretical refinement and methodological diversification are still needed, especially in patient-centered telemedicine applications.

The lower-left quadrant, which represents Emerging or Declining Themes, includes terms such as “artificial intelligence”, “machine learning”, “ethics”, “deep learning” and “big data”. These themes have both low centrality and low density, indicating that they are either newly emerging areas or topics whose influence within the field has not yet been fully consolidated. Considering the rapid development of AI-based decision support systems, predictive analytics, and data-driven healthcare applications, these themes are more likely to represent emerging research directions rather than declining topics. Their position suggests that artificial intelligence, machine learning, deep learning, big data, and ethical considerations still require stronger conceptual integration with telemedicine, privacy, and security research. Therefore, this quadrant points to important opportunities for future studies focusing on responsible AI, ethical data use, algorithmic transparency, and secure intelligent telemedicine systems.

Discussion

This study provides a bibliometric assessment of 10 641 publications published between 2014 and April 2026 at the intersection of telemedicine, digital health, privacy, and security. The results highlight a notable rise in scientific output, particularly after 2020, when the COVID-19 pandemic accelerated the adoption of remote healthcare services and increased scholarly attention to secure digital health infrastructures. This growth pattern is consistent with the broader literature, which emphasizes telemedicine as an important mechanism for improving healthcare accessibility, reducing geographical barriers, and supporting remote patient care, especially in underserved regions. However, the findings also indicate that the rapid expansion of telemedicine has been accompanied by increasing concerns regarding privacy, secure data transmission, authentication, cybersecurity, and trust.

Regional disparities in scientific production require critical attention. The dominance of countries such as the United States, China, India, and several European countries may reflect stronger digital health infrastructures, higher research funding, more advanced regulatory frameworks, and greater institutional capacity for telemedicine research. In

contrast, lower publication activity in parts of Africa, South America, and some regions of Southeast Asia may indicate limited research visibility, weaker digital health infrastructure, lower investment capacity or underrepresentation in indexed databases. This imbalance is important because telemedicine is often considered a tool for reducing healthcare inequalities, yet research on telemedicine security appears to be concentrated in regions with stronger technological and academic capacity.

The thematic map indicates that the field is primarily driven by digital and mobile health-related themes, including “digital health”, “mHealth”, “eHealth” and “mobile health”, which appear as highly developed and central motor themes. In contrast, “telemedicine”, “telehealth”, “COVID-19”, “pandemic” and “patient” are positioned as basic themes, suggesting that they constitute the field’s foundational structure but still require further conceptual and methodological development. Security-related concepts such as “security”, “privacy” and “blockchain” appear as niche themes, indicating a specialized but relatively less integrated research stream. Meanwhile, “artificial intelligence”, “machine learning”, “deep learning”, “big data” and “ethics” are among emerging or declining themes, suggesting that these topics represent important future directions requiring stronger integration with telemedicine security and privacy research.

A critical interpretation of these thematic positions suggests that privacy and security remain niche themes not because they are marginal in practical terms, but because they have developed as technically specialized subfields within the broader telemedicine literature. Telemedicine research has historically focused on access to care, remote consultation, patient monitoring, and service delivery, especially during and after the COVID-19 pandemic. In contrast, privacy, cybersecurity, authentication, and encryption require more specialized technical, legal, and infrastructural expertise. As a result, these topics may have developed in relatively concentrated research communities rather than becoming fully integrated into mainstream telemedicine studies. This finding indicates an important gap between the operational expansion of telemedicine services and the systematic integration of security-by-design and privacy-by-design principles into telemedicine research.

The position of blockchain as a niche theme can also be interpreted critically. Although blockchain has been widely proposed as a promising solution for secure data sharing, decentralized access control, auditability, and patient-centered health data management, its integration into mainstream telemedicine research remains limited. This may be related to several factors, including scalability problems, interoperability challenges with existing health information systems, regulatory uncertainty, high implementation costs, and the technical complexity of blockchain-based architectures. In many studies, blockchain is still discussed at the conceptual or prototype level rather than being evaluated through large-scale clinical or institutional implementation. Therefore, its niche position suggests that blockchain-based telemedicine security has reached a certain level of technical development but has not yet achieved broad practical diffusion within the wider digital health ecosystem.

The weak integration of artificial intelligence and cybersecurity research represents another important issue. AI, machine learning, deep learning, and big data appear as emerging themes, but their low centrality indicates that they are not yet strongly connected with telemedicine security and privacy research. One possible explanation is that AI-related telemedicine studies often prioritize diagnosis, prediction, clinical decision support, image analysis, or patient monitoring, whereas cybersecurity studies focus on authentication, encryption, access control, secure communication, and system resilience. This disciplinary separation may limit the development of integrated research on secure, explainable, and privacy-preserving AI-based telemedicine systems.

Theoretical Contribution

The theoretical contribution of this study lies in its bibliometric mapping of telemedicine security as a multidisciplinary research domain. By integrating publication trends, keyword patterns, country-level productivity, institutional contributions, and thematic mapping, the study identifies how telemedicine research has shifted from a general healthcare access topic toward a more complex field shaped by digital health, privacy, cybersecurity, mobile platforms, blockchain, and artificial intelligence. In doing so, the study contributes to the literature by clarifying the conceptual relationships among foundational, specialized, motor, and emerging themes in telemedicine security research.

Practical Contribution

The practical contribution of the study is that it provides guidance for healthcare managers, policymakers, system designers, and researchers who aim to develop safer and more sustainable telemedicine systems. The findings suggest that successful telemedicine implementation requires more than the availability of remote consultation platforms. It also requires secure data sharing frameworks, robust authentication and access control mechanisms, privacy-preserving infrastructures, cybersecurity risk management, patient-centered design, and ethical governance of AI-based tools. In particular, healthcare organizations should consider privacy and security as core design principles rather than secondary technical concerns. Policymakers should also support regulatory frameworks that balance innovation, patient protection, interoperability, and equitable access.

Future Research

It is possible to propose several promising directions for future research based on the thematic structure of the field. Although “security”, “privacy” and “blockchain” appear as niche themes, their relatively limited centrality suggests that these topics are not yet fully integrated into the broader telemedicine and digital health literature. Therefore, future studies should examine how blockchain-based systems, authentication mechanisms, access control models and encryption protocols can be implemented in real-world telemedicine platforms to improve secure data sharing, patient data verifiability, interoperability and trust. In addition, the position of “artificial intelligence”, “machine

learning”, “deep learning”, “big data” and “ethics” in the Emerging or Declining Themes quadrant indicates that these areas still require stronger conceptual integration with telemedicine security research. Future studies should therefore address AI-supported telemedicine applications in relation to data privacy, cybersecurity, algorithmic transparency, accountability and ethical governance. Finally, because “telemedicine”, “telehealth”, “COVID-19”, “pandemic” and “patient” appear as basic themes, future research should move beyond pandemic-driven adoption and focus on long-term patient-centered telemedicine services, including user trust, digital literacy, sociocultural differences and equitable access to secure digital healthcare.

In the literature, differences in telemedicine use among individuals with different sociocultural, regional, and economic backgrounds have still been investigated to a limited extent. Therefore, future research can comparatively address the cultural, social and economic and digital literacy-related factors affecting user acceptance, trust, and continued use of telemedicine services. In addition, smart contracts and security protocols may offer an important line of defense against unauthorized access, data manipulation, and weakness in patient data sharing. Future studies can investigate how these protocols can be integrated into telemedicine applications in relation to legal compliance, ethical governance, and patient privacy.

Limitations

Although this study provides a comprehensive bibliometric overview of telemedicine, security, privacy, and digital health research, several limitations should be acknowledged. First, the dataset was restricted to publications retrieved from Web of Science and PubMed. These databases were selected because PubMed offers strong coverage of biomedical and health-related literature, while Web of Science provides high-quality multidisciplinary coverage and is widely used in bibliometric studies. However, Scopus was not included in the data collection process. Given the broad multidisciplinary coverage of Scopus, its exclusion may have limited the comprehensiveness of the dataset and may have resulted in the omission of some relevant publications. Integrating three large databases may also create methodological challenges related to duplicate removal, metadata harmonization, indexing differences, and the standardization of bibliometric indicators. Nevertheless, future studies may incorporate Scopus and other databases to provide a broader representation of the literature.

Second, the analysis was limited to English-language publications. This restriction was applied to ensure consistency in data processing, keyword interpretation, and thematic analysis. However, it may have introduced language bias by excluding relevant studies published in other languages. Since telemedicine, privacy and security are globally relevant research areas, future studies may benefit from including multilingual datasets to better capture regional and non-English contributions.

Third, the findings depend on the selected search keywords and the indexing practices of the databases used. Although the search strategy was designed to cover the major terms related to telemedicine, digital health, security, privacy, cybersecurity,

authentication, encryption and blockchain, some relevant studies may not have been retrieved if they used different terminology or were indexed differently. Therefore, the results should be interpreted within the boundaries of the search query and database indexing structure.

Finally, bibliometric analyses may be affected by inconsistencies in author names, institutional affiliations, and metadata records. In the present study, institutional names were reviewed and standardized where clear duplicate or variant forms were detected. However, variations in author initials, institutional naming conventions, spelling differences, abbreviated affiliation formats, and database indexing practices may still influence the accuracy of author- and institution-level productivity analyses. Future research may use additional data-cleaning and name-disambiguation procedures to further improve the precision of bibliometric mapping.

Conclusion

This study examined the research landscape at the intersection of telemedicine, security, privacy and digital health through a bibliometric analysis of 10,641 publications indexed in Web of Science and PubMed between 2014 and April 2026. The findings show that scholarly interest in this field has expanded considerably, especially after 2020, reflecting the rapid growth of telemedicine services and the increasing importance of secure digital health infrastructures.

The results indicate that telemedicine security research is shaped by several interconnected thematic areas. Digital health, mHealth, eHealth, and mobile health appear as central and well-developed motor themes, while telemedicine, telehealth, COVID-19, pandemic and patient-related terms constitute the foundational structure of the field. Security, privacy and blockchain emerge as specialized niche themes, suggesting that these topics are technically developed but still require stronger integration into mainstream telemedicine research. Artificial intelligence, machine learning, deep learning, big data and ethics represent emerging research directions that require further conceptual and practical development in relation to privacy, cybersecurity, and responsible digital healthcare.

Overall, the study contributes to the literature by mapping the evolution, structure and thematic orientation of telemedicine security and privacy research. It also provides practical implications for healthcare managers, policymakers, and system designers by emphasizing the need to treat privacy, cybersecurity, authentication, access control and ethical AI governance as core components of telemedicine systems. Future research should continue to integrate security and privacy mechanisms into real-world telemedicine applications, develop privacy-preserving AI-based healthcare systems, and address sociocultural, regional and digital literacy-related differences in user acceptance. Such efforts can support the development of safer, more trustworthy, inclusive and sustainable digital health systems.

REFERENCES

1. Haleem A, Javaid M, Singh RP, Suman R. Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sensors International*. 2021;2:1-12.
2. Anawade PA, Sharma D, Gahane S. A comprehensive review on exploring the impact of telemedicine on healthcare accessibility. *Cureus*. 2024;16(3):1-12.
3. Stoltzfus M, Kaur A, Chawla A, Gupta V, Anamika FNU, Jain R. The role of telemedicine in healthcare: an overview and update. *The Egyptian Journal of Internal Medicine*. 2023;35(1):1-5.
4. Kruse CS, Karem P, Shifflett K, Vegi L, Ravi K, Brooks M. Evaluating barriers to adopting telemedicine worldwide: a systematic review. *Journal of Telemedicine and Telecare*. 2018;24(1):4-12.
5. Bernabe M, Ebardo R. Barriers leading to the discontinuance of telemedicine among healthcare providers: a systematic review. *Data Metadata*. 2025;4:440.
6. Moffatt JJ, Eley DS. Barriers to the up-take of telemedicine in Australia—a view from providers. *Rural and Remote Health*. 2011;11(1):116-121.
7. Jena A, Bist L, Agarwal S, Bhuyan D, Abraham G, Borah K. Policy innovation in healthcare: exploring the adoption and implementation of telemedicine. *Health*. 2025;5:6.
8. Hamdan IM, Alkhader E. Telemedicine adoption from the perspective of healthcare providers: barriers and challenges. *Journal of Pharmaceutical Health Services Research*. 2025;16(4):rmafo19.
9. Dang VA, Vu Khanh Q, Nguyen VH, Nguyen T, Nguyen DC. Intelligent healthcare: Integration of emerging technologies and Internet of Things for humanity. *Sensors*. 2023;23(9):1-24.
10. Park HA. Secure Telemedicine System. In *2018 International Conference on Computational Science and Computational Intelligence (CSCI)*; 2018 December; Las Vegas, NV, USA. IEEE; p. 732-737.
11. Pavithra V, Chandrasekaran J. Developing security solutions for telemedicine applications: medical image encryption and watermarking. In *Research anthology on telemedicine efficacy, adoption, and impact on healthcare delivery*. Hershey, PA: IGI Global Scientific Publishing; 2021. p. 612-631.
12. Shirisha P, Soni S, Hemamalini V, et al. Secure Blockchain-Powered Health Record Management for Telemedicine and Remote Patient Monitoring Using

Decentralized Encryption. In *2025 3rd International Conference on Cyber Resilience (ICCR)*; 2025, July; IEEE; p. 1-10.

13. Mehta N, Chaudhary A. Infrastructure and system of telemedicine and remote health monitoring. In: Tanupriya Choudhury, Avita Katal, Jung-Sup Um, Ajay Rana and Marwan Al-Akaidi, eds. *Telemedicine: The Computer Transformation of Healthcare*. Cham: Springer International Publishing; 2022.
14. Santamato V, Tricase C, Faccilongo N, Iacoviello M, Marengo A. Exploring the impact of artificial intelligence on healthcare management: A combined systematic review and machine-learning approach. *Applied Sciences*. 2024;14(22):1-30.
15. Chang MJ, Jung JK, Park MW, Chung TM. Strategy to reinforce security in telemedicine services. In: *2015 17th International Conference on Advanced Communication Technology (ICACT)*. July 1-3, South Korea. 2015.
16. Sandhu RS, Samarati P. Authentication, Access Controls, and Intrusion Detection. *The Computer Science and Engineering Handbook*. 1997; 1: 929-1.
17. Ferraiolo D, Kuhn R, Hu V. Authentication, Authorization, Access Control, and Privilege Management. *Wiley Handbook of Science and Technology for Homeland Security*. 2008;1:1-12.
18. Chen HM, Lo JW, Yeh CK. An efficient and secure dynamic id-based authentication scheme for telecare medical information systems. *Journal of medical systems*. 2012;36(6):3907-3915.
19. Lin TW, Hsu CL, Le TV, Lu CF, Huang BY. A smartcard-based user-controlled single sign-on for privacy preservation in 5G-IoT telemedicine systems. *Sensors*, 2021; 21(8): 2880.
20. Jian G, Feng R. Cryptanalysis and improvement of an improved two factor authentication scheme for telecare medicine information systems. *arXiv preprint arXiv:1607.01471*. 2016.
21. Chatterjee S, Roy S, Das AK, et al. On the design of fine grained access control with user authentication scheme for telecare medicine information systems. *IEEE Access*. 2017;5:7012-7030.
22. Hamzah M, Husna D, Astha Ekadiyanto F, et al. Access control design based on user role type in telemedicine system using ethereum blockchain. In *Proceedings of the 7th International Conference on Communication and Information Processing*; 2021 December. p. 112-117.

- 23.** Lee S, Kim J, Kwon Y, Kim T, Cho S. Privacy preservation in patient information exchange systems based on blockchain: system design study. *Journal of Medical Internet Research*. 2022;24(3):e29108.
- 24.** Hossain M, Islam SR, Ali F, Kwak KS, Hasan R. An Internet of Things-based health prescription assistant and its security system design. *Future Generation Computer Systems*. 2018;82:422-439.
- 25.** Haldkar CD, Sharma S, Sharma A, Sharma A. Cybersecurity in the age of connected healthcare. In *Machine and Human Together: Innovating Healthcare with Technology*. Bentham Science Publishers; 2025. p. 340-364.
- 26.** Jafar U, Hussain HA. Addressing unique cybersecurity challenges in telehealth and remote physiologic monitoring. In *Secure Health*. Boca Raton, CRC Press; 2024. p. 124-168.
- 27.** Bhardwaj M, Juneja Y, Sidana N. Cybersecurity in healthcare: risks, vulnerabilities, and ethical imperatives. In *Organ Trafficking Prevention in the Healthcare Sector: Examining the Co-Creation of Cybersecurity Value*. Hershey, PA: IGI Global Scientific Publishing; 2026. p. 1-34.
- 28.** Geada N. Navigating the digital frontier telemedicine compliance. In *Improving Security, Privacy, and Connectivity Among Telemedicine Platforms*. Hershey, PA: IGI Global Scientific Publishing; 2024. p. 61-70.
- 29.** Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*. 2021;133:285-296.
- 30.** Passas I. Bibliometric analysis: the main steps. *Encyclopedia*. 2024;4(2):1014-1025.
- 31.** Quesado P, Costa Oliveira H, Silva R. Integrating sustainability goals into the balanced scorecard: A bibliometric analysis of the sustainability balanced scorecard. *Measuring Business Excellence*. 2025;29(2):352-367.
- 32.** Aria M, Cuccurullo C. Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*. 2017;11(4):959-975.

A Bibliometric Analysis of Surgical Site Infections in Pediatric Surgery

Aydın NART*, Meltem ASLAN**

Abstract

Aim: This study aims to examine the existing scientific literature on surgical site infections in the field of pediatric surgery through a bibliometric analysis. In this context, it aims to identify publication trends and highlight current research gaps within the field.

Method: A total of 956 articles were included in the analysis based on a search conducted on October 8, 2025, in the Web of Science database using keywords such as “surgical site infection,” “children,” and “pediatric surgery.” The bibliometric evaluation was carried out using the Biblioshiny interface. Parameters such as publication years, keywords, countries, journals, and citations were analyzed.

Results: A total of 956 articles published between 1987 and 2025 included 8,624 authors. The United States was identified as the country with the highest number of publications. Journal of Pediatric Surgery was found to be the journal with the highest number of publications and citations. According to the Keywords Plus analysis, the most frequently used terms were “children” (n=413, 14%), “surgical site infection” (n=184, 6%), “surgery” (n=163, 5%), “complications” (n=162, 5%), and “risk factors” (n=144, 5%).

Conclusion: This study provides a structured and comprehensive overview of the scientific research on surgical site infections in pediatric surgery. The findings indicate that SSIs have been the focus of scientific investigation for many years and continue to hold clinical and academic importance today. However, in light of the gaps identified in the existing literature, the need for more comprehensive and in-depth studies is evident.

Keywords: Bibliometric analysis, child, surgical site infection.

Pediatric Cerrahide Cerrahi Alan Enfeksiyonları Üzerine Bibliyometrik Analiz

Öz

Amaç: Bu çalışmanın amacı, pediatrik cerrahi alanında cerrahi alan enfeksiyonu ile ilgili mevcut bilimsel literatürü bibliyometrik analiz yöntemiyle incelemektir. Bu kapsamda, alandaki yayın eğilimleri ve mevcut araştırma boşluklarının ortaya konulması hedeflenmiştir.

Yöntem: 8 Ekim 2025 tarihinde, Web of Science veri tabanında “surgical site infection”, “children” ve “pediatric surgery” gibi terimler kullanılarak yapılan tarama sonucunda 956 makale analize dahil edilmiştir.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 13.10.2025 **Kabul / Accepted:** 11.03.2026

DOI: <https://doi.org/10.38079/igusabder.1803077>

* Asst. Prof., Istanbul Esenyurt University, Faculty of Health Sciences, Department of Nursing, Istanbul, Türkiye.

E-mail: aydinnart@esenyurt.edu.tr [ORCID https://orcid.org/0000-0001-8700-8889](https://orcid.org/0000-0001-8700-8889)

** Asst. Prof., Istanbul Esenyurt University, Faculty of Health Sciences, Department of Midwifery, Istanbul, Türkiye.

E-mail: meltemaslan@esenyurt.edu.tr [ORCID https://orcid.org/0000-0003-3847-2233](https://orcid.org/0000-0003-3847-2233)

Bibliyometrik değerdendirmede Biblioshiny arayüzü kullanılarak yapılmıştır. Yayın yılları, anahtar kelimeler, ülkeler dergi ve atıflar analiz edilmiştir.

Bulgular: 1987–2025 yılları arasında yayımlanan 956 makalede toplam 8624 yazar yer almıştır. En fazla yayına sahip ülkenin Amerika Birleşik Devletleri olduğu belirlenmiştir. En fazla yayın ve atıf yapılan dergi Journal of Pediatric Surgery dergisidir. Keywords Plus analizine göre en sık kullanılan terimler “children” (n= 413, %14), “surgical site infection” (n = 184, %6), “surgery” (n = 163, %5), “complications” (n = 162, %5), and “risk factors” (n = 144, %5) olarak belirlenmiştir.

Sonuç: Çalışmada, pediatrik cerrahi alanında cerrahi alan enfeksiyonları üzerine yürütülen mevcut bilimsel çalışmalara ilişkin yapılandırılmış ve kapsamlı bir genel bakış sunmaktadır. Elde edilen bulgular, cerrahi alan enfeksiyonlarının uzun süredir bilimsel araştırmalara konu olduğunu ve günümüzde de klinik ve akademik açıdan önemini koruduğunu göstermektedir. Bununla birlikte, mevcut literatürdeki boşluklar doğrultusunda daha kapsamlı ve derinlemesine çalışmaların gerekliliği ön plana çıkmaktadır.

Anahtar Sözcükler: Bibliyometrik analiz, çocuk, cerrahi alan enfeksiyonu.

Introduction

Surgical site infections (SSIs) are infections that develop at the surgical incision site or elsewhere in the body within 30 to 90 days after a surgical procedure^{1,2}. These infections are most commonly caused by microorganisms residing on the skin surface, and the primary intervention for their prevention is the removal of transient microorganisms from the body surface³. Despite advancements in asepsis and antisepsis practices, surgical techniques, and antibiotic prophylaxis, SSIs remain one of the most common postoperative complications worldwide, contributing significantly to high morbidity and mortality rates^{4,5}.

SSIs are one of the most frequent hospital-acquired infections in children and pose a substantial burden on patients, their families, and the healthcare system⁶. Approximately one-quarter of SSI cases in pediatric surgical patients are among the leading causes of hospital readmissions⁷. According to the World Health Organization, nearly 50% of SSIs are preventable⁸. The implementation of prevention bundles, including skin antisepsis, has been shown to yield successful outcomes in reducing SSI rates among children⁹.

When examining the bibliometric analysis method, it is described as an analytical approach that employs statistical tools and mathematical techniques to measure mutual relationships and impacts. The primary purpose of conducting such an analysis is to provide a general overview of the literature by obtaining outputs related to the year of publication, keywords used, citation counts, topics, authors, countries, and institutions^{10,11}. In the results, the main objective is to reveal both the quantitative and qualitative data of the scientific literature¹². Bibliometric studies are also considered among the methods that uncover the relationships among stakeholders of scientific communication and aim to determine the level of contribution between these actors¹³.

Material and Methods

This study utilized bibliometric analysis and science mapping techniques. A search was conducted in the Web of Science (WoS) database using the keywords “surgical site infection,” “children,” and “pediatric surgery.” After applying specific filters, a total of 956 peer-reviewed studies were identified. Studies focusing on SSIs in the pediatric field were included without any restriction on publication year or author name. Only publications written in English and classified as “Article” were included in the analysis, while reviews, book chapters, and letters to the editor were excluded.

In bibliometric analyses, because large datasets are typically involved, it is crucial to restrict the database to a specific time period to enhance the search process's efficiency and effectiveness, thereby optimizing the results¹³. Based on this consideration, the search was conducted in the WoS database on a single day (October 8, 2025) due to the continuous flow of scientific data into the database. The dataset compiled in this study was analyzed using the Biblioshiny program to enable a comprehensive and multidimensional examination of the literature.

Research Questions

- 1) What is the annual distribution of scientific publications on SSIs in the field of pediatric surgery, and what are the publication trends over time?
- 2) Which countries, institutions, and authors have produced the highest number of publications on SSIs in pediatric surgery?
- 3) Which journals have published the highest number of articles and received the greatest number of citations in this field?
- 4) What are the most frequently used keywords and the prominent research themes in the literature on SSIs in pediatric surgery?
- 5) According to the keyword co-occurrence analysis, which concepts show the strongest relationships within the literature on SSIs in pediatric surgery?

Results

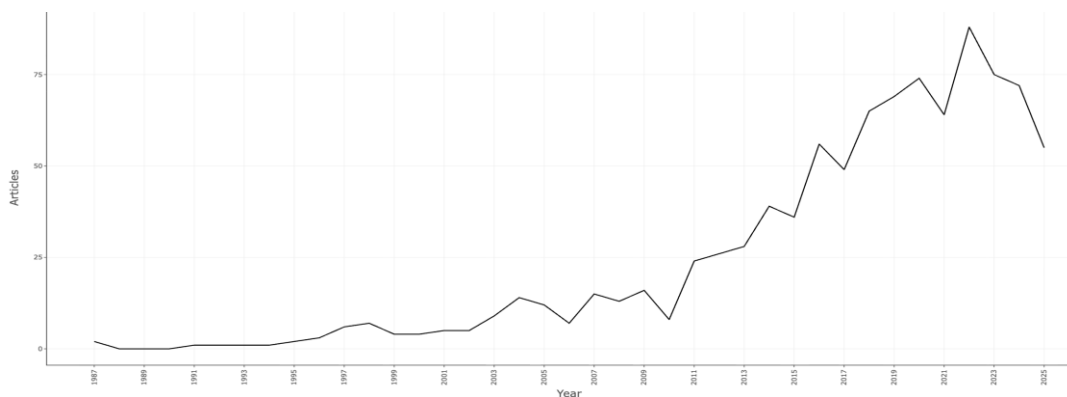
Between 1987 and 2025, a total of 956 articles addressing the topic of SSIs in the field of pediatric surgery were published. A total of 8,624 authors were identified, with only 18 articles written by a single researcher. The rate of international collaboration among the articles was 11.9% (Fig.1.).

Figure 1. Main data statistics.



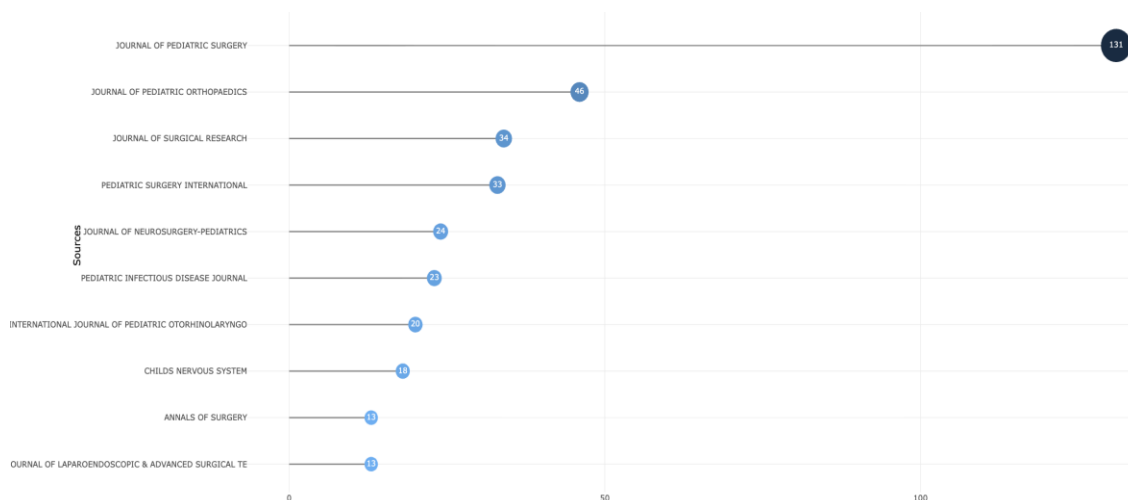
When analyzing the annual distribution of scientific production, no consistent growth trend in publication performance was observed between 1987 and 2025. The highest number of articles was recorded in 2022 (Fig.2.).

Figure 2. Annual scientific production.



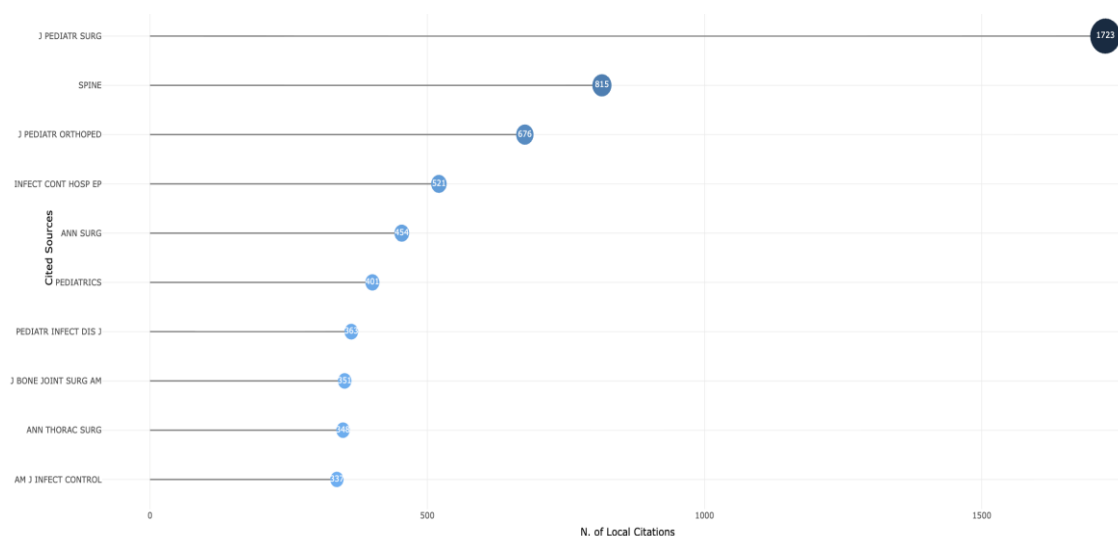
Among the most relevant sources, the *Journal of Pediatric Surgery* was identified as the journal with by far the highest number of publications, totaling 131 articles (Fig.3.).

Figure 3. Most relevant sources.



This finding reveals which journals are the most influential and most frequently cited in the field. With 1,723 citations, the *Journal of Pediatric Surgery* was determined to be the journal with by far the most citations (Fig.4.).

Figure 4. Most local cited sources.

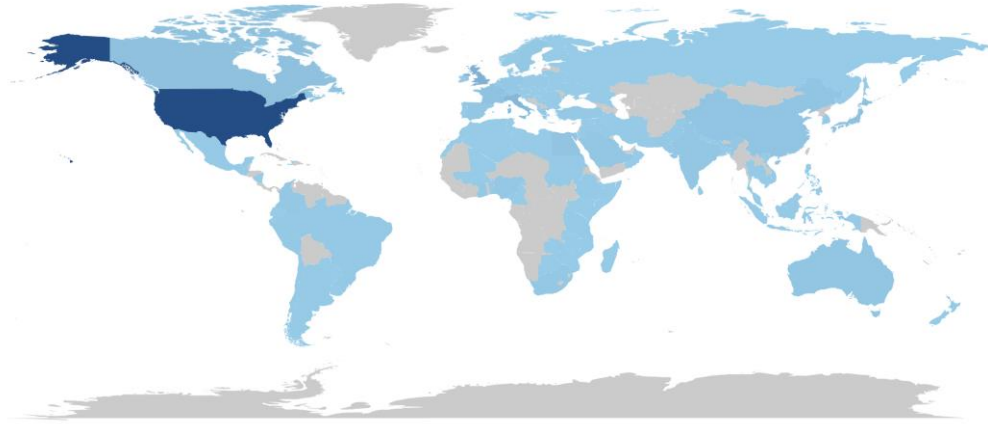


A review of the global distribution of scientific publications shows that the United States ranks first in terms of output. Figure 5 illustrates the top 10 countries with the highest number of published articles. In Figure 6, the country marked in dark blue represents the one with the greatest publication volume. Countries shaded in lighter blue have produced fewer publications, while those in gray signify regions with no publications in the respective field to date.

Figure 5. Number of scientific articles produced by country.

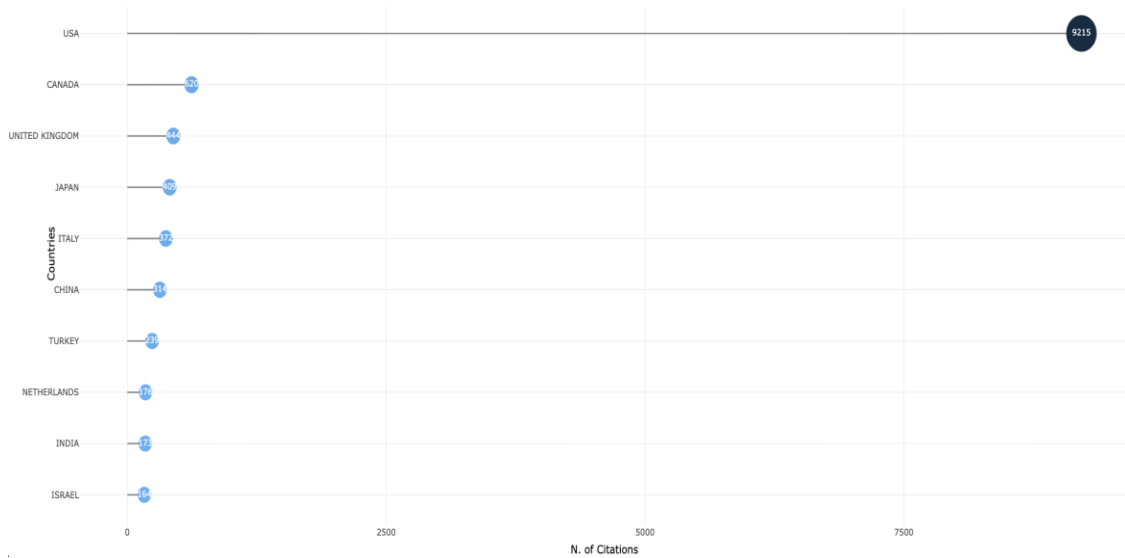
Country	Freq
USA	2115
UK	444
ITALY	327
CANADA	143
JAPAN	141
FRANCE	137
CHINA	97
EGYPT	89
AUSTRALIA	80
SWITZERLAND	76

Figure 6. Scientific production by country.



Analyses of the global distribution of scientific output indicate that the United States leads in the number of publications. Consistent with this, it has also been identified as the country with the highest citation count, totaling 9,215 citations (Figure 7).

Figure 7. Most cited countries.



According to the analysis results, the most frequently used keywords include “children” (n=413; 14%), “surgical site infection” (n=184; 6%), “surgery” (n=163; 5%), “complications” (n=162; 5%), and “risk factors” (n=144; 5%) (Figure 8).

There are numerous studies related to SSIs in the field of pediatric surgery. The aim of this study is to map the literature and make the existing body of knowledge visible. No consistent growth trend in publication performance was observed for the articles reviewed in the study, which span from 1987 to 2025. A significant decline occurred in 2021, followed by the highest number of publications in 2022. A similar trend was identified in a related study, where a decrease in the number of publications was observed in 2020, with a subsequent increase in 2021. These results are thought to be due to the isolation measures and the shift in research focus caused by the COVID-19 pandemic¹⁶.

The study found that, among all countries analyzed, the United States had the highest volume of scientific publications. Additionally, the most influential and most frequently cited journal was identified as the Journal of Pediatric Surgery. The Journal of Pediatric Surgery is a US-based, internationally respected, and high-impact scientific journal in the field of pediatric surgery. A review of the literature shows that the United States is one of the leading countries in scientific productivity worldwide. This is attributed to its strong research infrastructure, funding mechanisms, and publishing system¹⁷. The increasing trend observed in the nursing research literature (in both funded and non-funded studies) indicates a rising trend in research funding within the field of nursing. Furthermore, an examination of regionally focused literature production shows that a large portion of scientific publications is produced by more developed and economically powerful countries¹⁸.

According to the results of the Keyword Plus analysis, the most frequently used keywords include “children” (n = 413, 14%), “surgical site infection” (n = 184, 6%), “surgery” (n = 163, 5%), “complications” (n = 162, 5%), and “risk factors” (n = 144, 5%). The network analysis results visualize the relationships and connections between these keywords. Among the analyzed literature, the keyword with the strongest connections was identified as “children”. This term is at the center of the research area and shows strong associations with other themes. Additionally, the terms “complications” and “risk factors” were found to be closely related to SSIs in the literature. SSIs are considered one of the most common and complex complications occurring in the postoperative period; they increase morbidity rates, prolong hospital stays, raise healthcare costs, and significantly contribute to mortality in severe cases¹⁹. Patient-specific risk factors play a decisive role in the development of SSIs. These factors include age (particularly in newborns and the elderly), malnutrition, obesity, diabetes, immunosuppression, smoking, and chronic conditions such as kidney or liver failure²⁰. These results emphasize the need for thorough evaluation of individual risk factors and the creation of patient-focused prevention strategies to reduce SSIs. Overall, our study’s findings were found to be in alignment with the existing body of literature.

Conclusion

This bibliometric analysis provides a structured and comprehensive overview of the scientific literature on SSIs in the field of pediatric surgery. The findings demonstrate that SSIs have remained a persistent focus of academic and clinical research over several

decades, underscoring their ongoing importance as a major patient safety and quality-of-care issue in pediatric surgical practice. The analysis reveals that research output in this field is largely concentrated in high-income countries, with the United States leading both in publication volume and citation impact. This concentration highlights disparities in global research capacity and emphasizes the need to strengthen international collaboration, particularly involving low- and middle-income countries where the burden of SSIs may be substantial but underrepresented in the literature. Keyword and network analyses indicate that current research predominantly focuses on complications and patient-related risk factors, reflecting the clinical priority of understanding SSI etiology and prevention. These findings underscore the importance of individualized risk assessment and the development of targeted, evidence-based prevention strategies in pediatric surgical care. However, the literature also reveals gaps in areas such as standardized prevention protocols, implementation science, and context-specific interventions tailored to diverse healthcare settings. In conclusion, this study contributes to the existing body of knowledge by mapping publication trends, thematic priorities, and research gaps in pediatric surgical site infection research. The results provide a valuable reference framework for clinicians, researchers, and policymakers, and may guide future studies aimed at improving infection control practices, enhancing patient safety, and optimizing surgical outcomes in pediatric populations.

Limitations

This study has several limitations. Restricting the analysis to the Web of Science (WoS) database may have limited the comprehensive representation of the literature. In addition, including only studies published in English may have resulted in the exclusion of important research in other languages, thereby limiting global representation. Finally, limiting the scope to publications classified solely as “articles” may have led to the exclusion of potentially relevant publication types, such as reviews, letters, and conference proceedings.

REFERENCE

1. Ralph N, Brown L, McKillop KL, et al. Oral nutritional supplements for preventing surgical site infections: protocol for a systematic review and meta-analysis. *Syst Rev.* 2020;9(1):37.
2. Goldberg L. Developing a surgical site infection prevention bundle for patients undergoing elective spine surgery. *AORN J.* 2020;112(2):158-164.
3. Link T. Guidelines in practice: preoperative patient skin antisepsis. *AORN J.* 2022;115(2):156-166.
4. NIHR Global Research Health Unit on Global Surgery. Reducing surgical site infections in low-income and middle-income countries (FALCON): a pragmatic,

multicentre, stratified, randomised controlled trial. *Lancet*. 2021;398(10312):1687-1699.

5. Weiser MR, Gonen M, Usiak S, et al; Memorial Sloan Kettering Multidisciplinary Surgical-Site Infection Reduction Team. Effectiveness of a multidisciplinary patient care bundle for reducing surgical-site infections. *Br J Surg*. 2018;105(12):1680-1687.
6. Zingg W, Hopkins S, Gayet-Ageron A, et al. Health-care-associated infections in neonates, children, and adolescents: an analysis of paediatric data from the European Centre for Disease Prevention and Control point-prevalence survey. *Lancet Infect Dis*. 2017;17(4):381-389.
7. Kulaylat AN, Rocourt DV, Tsai AY, et al. Understanding readmissions in children undergoing surgery: a pediatric NSQIP analysis. *J Pediatr Surg*. 2018;53(7):1280-1287.
8. World Health Organization. *Global Guidelines for the Prevention of Surgical Site Infection*. Geneva: World Health Organization; 2018. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK536404/>.
9. Toltzis P, O’Riordan M, Cunningham DJ, et al. A statewide collaborative to reduce pediatric surgical site infections. *Pediatrics*. 2014;134(4):e1174-e1180.
10. Unal A, Teskereci G. Mapping the evidence-based practice research field in nursing from 1995 to 2021: a bibliometric analysis. *Int J Nurs Knowl*. 2022;33(3):196-206.
11. Kantek F, Kurnaz H, Yeşilbaş H. Sağlık ve hemşirelik yönetimi dergisinin bibliyometrik analizi. *Sağlık ve Hemşirelik Yönetimi Derg*. 2019;6(3):228-237.
12. Şenel E. The last three decades of contact dermatitis: a bibliometric analysis of global publications on contact dermatitis. *J Dermatol Nurses Assoc*. 2020;12(5):223-231.
13. Yılmaz K. Sosyal bilimlerde ve eğitim bilimlerinde sistematik derleme, meta değerlendirme ve bibliyometrik analizler. *MANAS Sos Araştırmalar Derg*. 2021;10(2):1457-1490.
14. Turhan Damar H, Ögce Aktaş F. Bibliometric analysis of studies on surgical site infections in nursing (2000-2022). *Gevher Nesibe J Med Health Sci*. 2022;7(20):111-120.
15. Kolasiński W. Surgical site infections: review of current knowledge, methods of prevention. *Pol Przegl Chir*. 2018;91(4):41-47.

16. Özkan E, Sürmeli Ş. Cerrahi alan enfeksiyonuna yönelik bibliyometrik analiz ve bilim haritalama: tanımlayıcı araştırma. *Türkiye Klin J Nurs Sci.* 2023;15(3).
17. Zeng G, Wu Q. Global production of nursing research: a 10-year survey of subspecialty nursing journals. *Int J Nurs Pract.* 2022;28(1):e13027.
18. Kokol P, Železnik D, Završnik J, Blažun Vošner H. Nursing research literature production in terms of the scope of country and health determinants: a bibliometric study. *J Nurs Scholarsh.* 2019;51(5):590-598.
19. Singh R, Singla P, Chaudhary U. Surgical site infection: classification, risk factors, pathogenesis and preventive management. *Int J Pharm Res Health Sci.* 2014;2(3):203-214.
20. Hameed S, Hafeez MU, Abdullah W, Faisal UA, Javed A, Iqbal MA. Assessment of surgical site infections in surgeries at tertiary care hospitals in Southern Punjab, Pakistan: a retrospective study. *J Popul Ther Clin Pharmacol.* 2025;32(4):665-673.

Comparison of the Effectiveness of Schroth Exercise Method and Combined (Manual Therapy + Schroth Exercise Method) Method in Idiopathic Adolescent Scoliosis

Seyyede Sahra KARIMI*, Ömer ŞENEL**

Abstract

Aim: This study aimed to assess the impact of the Schroth exercise method alone versus a combination of the Schroth exercise method and manual therapy on adolescent idiopathic scoliosis patients.

Method: Participants aged 11-18 were divided into two groups: one practicing Schroth exercises and the other combining these exercises with manual therapy. Gibbosity, static and dynamic balance, visual perception, and quality of life were measured at baseline and after 3-month intervention period.

Results: Results indicated no significant differences between the groups in gender distribution, age, height, weight, body mass index, static and dynamic balance, gibbosity, and quality of life ($p>0.05$), except for visual perception, where the combined therapy group showed better results ($p<0.05$). Despite some observed benefits in gibbosity, quality of life, and static balance in the combined therapy group, these differences were not statistically significant ($p>0.05$).

Conclusion: The study concludes that, except for improved visual perception in the combined therapy group, there were no significant advantages over the Schroth exercise method alone in treating adolescent idiopathic scoliosis.

Keywords: Scoliosis, schroth, manual therapy.

İdiyopatik Adölesan Skolyozda Schroth Egzersiz Yöntemi ile Kombine (Manuel Terapi+ Schroth Egzersiz Yöntemi) Yöntemin Etkinliğinin Karşılaştırılması

Öz

Amaç: Bu çalışmada tek başına Schroth egzersiz yöntemine karşı Schroth egzersiz yöntemi ve manuel terapi kombinasyonunun adölesan idiyopatik skolyoz hastaları üzerindeki etkisinin değerlendirilmesi amaçlanmıştır.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 26.06.2025 **Kabul / Accepted:** 29.07.2026

DOI: <https://doi.org/10.38079/igusabder.1726723>

* (Corresponding Author) Graduated Physiotherapist, Department of Coaching Education/Training and Movement Science Program, Gazi University, Ankara, Türkiye. E-mail: saharakarimi1994@gmail.com

ORCID <https://orcid.org/0000-0003-4438-3595>

** Prof. Dr., Department of Coaching Education, Training and Movement Science Program, Sport Sciences Faculty, Gazi University, Ankara, Türkiye. E-mail: osenel@gazi.edu.tr **ORCID** <https://orcid.org/0000-0003-0364-9799>

ETHICAL STATEMENT: This research study was undertaken between January 2021 and July 2021. Non-Interventional Clinical Research Ethics Committee approval of the Gazi University was obtained before starting the study on 21.01.2021 (approval no:2020/21-876).

Yöntem: 11-18 yaş arası katılımcılar iki gruba ayrılmıştır: bir grup Schroth egzersizlerini uygularken diğeri bu egzersizleri manuel terapi ile birleştirmiştir. Başlangıçta ve 3 aylık tedavi periyodunun ardından gibozite, statik ve dinamik denge, görsel algı ve yaşam kalitesi ölçüldü.

Bulgular: Sonuçlar cinsiyet dağılımı, yaş, boy, kilo, vücut kitle indeksi, statik ve dinamik denge, gibozite ve yaşam kalitesi açısından gruplar arasında anlamlı bir fark olmadığını ($p>0,05$) ancak görsel algı açısından kombine terapi grubunun daha iyi sonuçlar gösterdiğini ortaya koydu ($p<0,05$). Kombine terapi grubunda gibozite, yaşam kalitesi ve statik dengede iyileşme gözlenmesine rağmen, bu farklılıklar istatistiksel olarak anlamlı değildi ($p>0,05$).

Sonuç: Bu çalışma kombine tedavi grubunun, görsel algıda iyileşme dışında adölesan idiyopatik skolyoz tedavisinde tek başına Schroth egzersiz yöntemine göre anlamlı bir avantaj sağlamadığı sonucuna varmıştır.

Anahtar Sözcükler: Skolyoz, schroth, manuel terapi.

Introduction

Adolescent idiopathic scoliosis (AIS) is a three-dimensional spinal deformity characterized by lateral curvature, vertebral rotation, and alterations in sagittal alignment. When a spinal curvature of 10° or more is measured on standing radiographs using the Cobb method, the condition is defined as scoliosis¹. AIS accounts for approximately 80% of all scoliosis cases and commonly develops during the adolescent growth period. The reported prevalence ranges between 0.47% and 5.2%, with a significantly higher prevalence and progression risk in females compared to males².

Although the exact etiology of AIS remains unclear, several mechanisms, including genetic predisposition, neuromuscular factors, connective tissue abnormalities, melatonin dysfunction, and biomechanical influences, have been proposed^{3,4}. The structural spinal deformity observed in AIS may lead to postural asymmetry, trunk rotation, rib prominence, and alterations in spinal alignment. Therefore, evaluating curve magnitude and trunk deformity using parameters such as Cobb angle and gibbosity is essential for clinical decision-making and treatment planning⁵.

Beyond structural changes, AIS may also affect postural control and balance mechanisms. The maintenance of upright posture depends on the integration of sensory inputs from the somatosensory, vestibular, and visual systems, which together provide spatial orientation and stability⁶⁻⁸. Previous studies have reported that individuals with scoliosis may demonstrate altered postural control and may rely on inaccurate spatial references when maintaining balance^{6,9,10}. Correct perception of the vertical axis is therefore an important component of postural regulation, and rehabilitation strategies aiming to improve neuromuscular control and postural awareness may contribute to improved functional outcomes^{6,11}.

In addition to biomechanical impairments, trunk deformity in AIS may influence body image and visual perception of posture. Visible asymmetries such as rib hump, shoulder imbalance, trunk rotation, and lumbar asymmetry may negatively affect adolescents' perception of their physical appearance^{6,12}. Since adolescence is a critical developmental

period during which body image plays an important role in psychosocial well-being, these deformities may lead to emotional distress and decreased self-esteem^{6,13}. For this reason, evaluating the visual perception of trunk deformity has become an important outcome measure in scoliosis rehabilitation. The Walter Reed Visual Assessment Scale (WRVAS) is frequently used to assess how individuals perceive their trunk deformity and body appearance^{5,14,15}.

Conservative treatment plays a crucial role in the management of mild to moderate AIS. The primary goals of conservative interventions include preventing curve progression, improving postural alignment, enhancing trunk stability, and improving cosmetic appearance and quality of life^{5,16}. Physiotherapeutic scoliosis-specific exercises (PSSE) represent one of the most commonly used conservative treatment approaches. These methods include several exercise-based protocols such as the Schroth Method, Barcelona Scoliosis Physical Therapy School, Side Shift, Lyon Approach, Dobomed, and Functional Individualized Therapy for Scoliosis¹⁷.

Among these approaches, the Schroth Method is one of the most widely studied PSSE techniques. It focuses on three-dimensional correction of spinal deformities through principles such as auto-elongation, deflection, derotation, rotational breathing, and postural stabilization¹⁸. Schroth exercises aim to restore muscular symmetry, improve postural awareness, and facilitate active spinal correction through neuromuscular re-education¹⁹.

In addition to exercise-based approaches, manual therapy techniques are sometimes incorporated into scoliosis rehabilitation programs to address mobility restrictions and improve neuromuscular function. Manual therapy may include joint mobilization and soft tissue techniques aimed at increasing spinal and thoracic mobility, improving rib cage flexibility, and enhancing proprioceptive input. These interventions may theoretically support corrective exercise programs by facilitating optimal movement patterns and improving trunk control. However, despite these potential benefits, the additional value of combining manual therapy with scoliosis-specific exercise programs remains insufficiently investigated in the current literature.

Therefore, a clear research gap exists regarding whether the integration of manual therapy with Schroth-based exercise programs provides additional benefits beyond exercise therapy alone in adolescents with idiopathic scoliosis.

The aim of this study was to compare the effectiveness of the Schroth exercise method and a combined intervention consisting of manual therapy and Schroth exercises in adolescents with idiopathic scoliosis. The study evaluated outcomes including balance, trunk rotation (gibbosity), quality of life, and visual perception of trunk deformity.

Material and Methods

This study was conducted to compare the effectiveness of the Schroth exercise method with a combined intervention consisting of manual therapy and the Schroth exercise

method in individuals with adolescent idiopathic scoliosis. A total of 23 individuals diagnosed with adolescent idiopathic scoliosis (mean age: 13.74 ± 1.86 years) who were followed by their physicians between January 1, 2021, and July 1, 2021 were included in the study.

A priori power analysis was conducted using G*Power software to estimate the required sample size based on previously reported effects of Schroth-based interventions in adolescents with scoliosis. The analysis indicated that a minimum sample size of 20 participants would be required to detect a moderate effect size with a statistical power of 80% at a significance level of $p < 0.05$. The final sample size of 23 participants therefore met the minimum requirement for statistical analysis.

The data for this study were collected in 2021. The delay between data collection and manuscript submission was primarily due to the time required for detailed data verification, statistical analyses, and preparation of the manuscript for publication. In addition, interruptions in clinical research activities and administrative processes during the COVID-19 period contributed to delays in the completion of the study report.

Participants

Initially, 33 male and female participants aged between 11 and 18 years (mean age 13.74 ± 1.86 years) with a diagnosis of adolescent idiopathic scoliosis voluntarily agreed to participate in the study. However, 10 participants withdrew from the study because they were unable to maintain regular participation in the home exercise program and clinical sessions. Participants who failed to attend two or more home or clinical exercise sessions during the intervention period were excluded from the final analysis due to non-compliance with the intervention protocol. Consequently, the study was completed with 23 participants.

Participants were allocated to two groups: the Schroth Exercise Group ($n=12$; 8 females, 4 males) and the Schroth + Manual Therapy Group ($n=11$; 7 females, 4 males). A simple random sampling method was used to assign participants to the exercise and combined groups. The randomization process was performed using numerical sequences generated by computer-assisted software. Before the measurements and tests were performed, demographic characteristics, including age (years), height (cm), and body weight (kg), were recorded. In addition, scoliosis-related characteristics such as the spinal region involved (thoracic, lumbar, or thoracolumbar), curve apex, Cobb angle, and bone maturation according to the Risser sign were determined from standing anterior–posterior full-spine radiographs.

Participants were eligible for inclusion if they were between 11 and 18 years of age, had a radiographically confirmed diagnosis of adolescent idiopathic scoliosis, and presented with mild to moderate scoliosis based on clinical and radiological parameters (Cobb angle between 10° and 40°). In addition, participants were required to be medically stable and able to understand and participate in exercise-based rehabilitation procedures.

Participants were excluded if they had previously undergone spinal surgery, had any diagnosed neurological disorder affecting motor control, had musculoskeletal pain that could interfere with exercise participation, or had cognitive or psychological conditions that could limit their ability to follow exercise instructions and participate in the intervention protocol.

Due to the nature of the exercise-based intervention, blinding of participants and treating physiotherapists was not feasible. However, all outcome measurements were performed by the same physiotherapist using standardized assessment procedures in order to minimize measurement variability.

Participants were followed for a total intervention period of three months.

Intervention Protocol

Schroth Exercise Program

In both groups, the Schroth exercise program consisted of exercises selected according to each participant's scoliosis curve type and affected spinal region. Although the exercise program was individualized, several core components of the Schroth method were consistently applied across all participants in order to standardize the intervention. These core components included auto-elongation, rotational angular breathing, trunk derotation exercises, and postural stabilization exercises aimed at improving spinal alignment and neuromuscular control.

Participants in the Schroth exercise group performed the exercise program five days per week at home and two days per week under the supervision of a specialized physiotherapist in the clinic for 12 weeks. Each supervised session lasted approximately 60 minutes and included postural correction training, breathing control techniques, and neuromuscular stabilization exercises. The number of repetitions, sets, and rest intervals were standardized across participants to maintain consistency of the exercise dosage.

To monitor adherence to the home exercise program, participants were asked to record their exercise sessions in a home exercise diary and submit weekly exercise videos. In addition, parents provided written confirmation regarding adherence to the home exercise protocol during each clinical visit.

Representative photographs demonstrating selected Schroth exercises used in the intervention program have been added as figures to illustrate the exercise positions and corrective principles applied during the treatment.

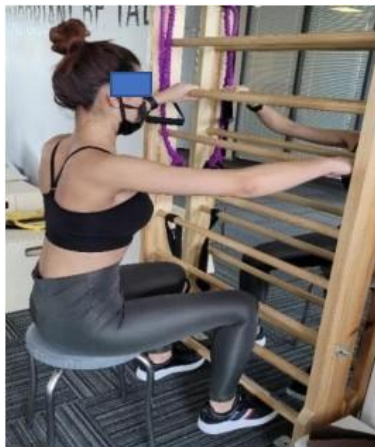
Figure 1. Schroth auto-elongation exercise.



Figure 2. Schroth side-lying correction exercise.



Figure 3. Schroth sitting Psoas synergy exercise.



Manual Therapy Intervention

Participants in the Schroth + Manual Therapy group received manual therapy in addition to the Schroth exercise program. Manual therapy was applied by an experienced physiotherapist once per week for six consecutive weeks during the three-month intervention period, resulting in a total of six sessions. Each manual therapy session lasted approximately 20–25 minutes.

The manual therapy protocol consisted of thoracic and lumbar joint mobilization techniques, soft tissue mobilization of paraspinal and intercostal muscles, and myofascial release techniques targeting areas with increased muscle tension or restricted mobility. Joint mobilizations were primarily applied to the apical vertebral segments associated with the scoliotic curvature to improve segmental spinal mobility and reduce asymmetrical movement restrictions.

The clinical rationale for the application of manual therapy was to improve spinal segmental mobility, reduce soft tissue restrictions, and enhance proprioceptive input. These effects were expected to facilitate improved neuromuscular control of the trunk and support the corrective mechanisms of the Schroth exercise program.

Data Collection Tools

To evaluate body image perception, deformity perception, and quality of life in individuals with adolescent idiopathic scoliosis, the Walter Reed Visual Assessment Scale (WRVAS) and the SRS-22 Scoliosis Patient Questionnaire were used. Static and dynamic balance were assessed using the Standing Stork Balance Test and the Y-Balance Test, respectively. The degree of trunk rotation (gibbosity) was evaluated using the Adams Forward Bend Test.

All assessments were performed twice: once before the intervention and once after the three-month treatment period.

Adams Forward Bend Test: The Adams forward bend test, conducted with a scoliometer, was applied to measure the rotation angle of the apex vertebra in degrees, and vertebral torsion was evaluated in the horizontal plane. During the test, participants bent forward while the examiner measured the angle of trunk rotation at the level of the apex vertebra. The scoliometer smartphone application was used in this study²⁰. Previous studies have demonstrated that smartphone-based scoliometer applications show high validity and reliability in measuring trunk rotation in individuals with scoliosis, with good agreement compared with traditional scoliometer measurements²⁰ (Figure 4).

Figure 4. Assessment of gibbosity using the Adams forward test⁵.



Standing Stork Balance Test: The Standing Stork Balance Test was used to evaluate static balance capacity. Prior to testing, the procedure was demonstrated to each participant, and three practice trials were allowed to ensure correct performance.

The test was performed barefoot with eyes open on both the right and left legs. Participants stood comfortably with their hands on their hips and placed the toes of one foot against the knee of the supporting leg. Upon the examiner's command, the participant raised the heel of the supporting foot and attempted to maintain balance on the toes. Timing began when the heel was lifted from the ground.

The test was terminated if the participant removed their hands from their hips, rotated or moved the supporting foot, lost contact between the unsupported foot and the knee, or if the heel of the supporting foot touched the floor. Three trials were performed for each leg and the mean value was recorded for analysis²¹. The Standing Stork Balance Test has been reported to demonstrate acceptable reliability for assessing static balance performance in adolescents and young adults²¹ (Figure 6).

Figure 6. Standing stroke balance test starting position ²¹.



Y-Balance Test: Dynamic balance was assessed using the Y-Balance Test, which measures reach distance in three directions: anterior (ANT), posteromedial (PM), and posterolateral (PL). Prior to testing, the participant's lower limb length was measured in the supine position as the distance between the anterior superior iliac spine and the medial malleolus.

Participants were asked to reach in each direction while maintaining the heel of the stance foot on the floor and keeping their hands on the iliac crest. Lifting the heel of the stance foot or removing the hands from the hips was considered an invalid trial.

Participants performed six trials in each direction with two minutes of rest between trials^{22,23}. Reach distances were normalized to leg length using the following formula:

$$\text{Normalized Score} = \text{Reach Distance} / \text{Leg Length}$$

A composite score was calculated using the following formula:

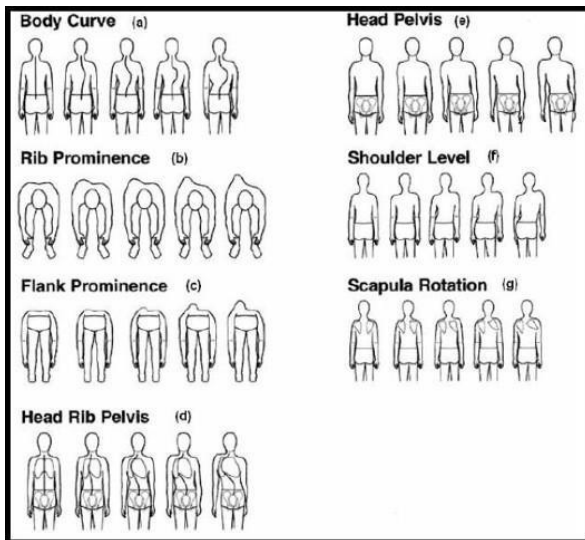
$$\text{Composite Score} = \frac{(\text{Anterior} + \text{Posteromedial} + \text{Posterolateral})}{(3 \times \text{Lower Extremity Length})} \times 100$$

The Y-Balance Test has been shown to have high intra-rater and inter-rater reliability for assessing dynamic balance in both adolescent and adult populations^{22,23}.

Walter Reed Visual Assessment Scale (WRVAS): The Walter Reed Visual Assessment Scale (WRVAS) includes illustrations evaluating rib prominence, lumbar prominence, spinal deformity, thoracic deformity, trunk imbalance, shoulder asymmetry, and scapular asymmetry^{5,14}. Each deformity category consists of five images representing increasing severity of the deformity. Participants are asked to select the image that best represents their perceived trunk appearance.

Each item is scored between 1 and 5, with higher scores indicating greater perceived deformity^{5,14}. WRVAS evaluates subjective perception of deformity rather than the actual radiological severity of scoliosis^{5,15}. The scale has demonstrated acceptable validity and reliability for assessing body image perception in individuals with scoliosis^{14,15}. In this study, the Turkish version of the scale¹⁹ was used (Figure 7).

Figure 7. WRVAS ².



SRS-22 Scoliosis Patient Questionnaire: Quality of life was assessed using the SRS-22 Scoliosis Patient Questionnaire, which consists of 22 questions divided into five domains: pain (questions 1,2,8,11,17), self-image (questions 4,6,10,14,19), function/activity (questions 5,9,12,15,18), mental health (questions 3,7,13,16,20), and satisfaction with treatment (questions 21,22).

Each item is scored from 1 (worst) to 5 (best). The satisfaction with the treatment domain ranges from 2–10 points, while the other domains range from 5–25 points. Domain

scores are calculated by dividing the total score of each domain by the number of items in that domain. Higher scores indicate better quality of life^{5,24}. The SRS-22 questionnaire has been widely used in scoliosis research and has demonstrated strong validity and reliability for assessing health-related quality of life in individuals with scoliosis²⁴.

Ethical Statement

Ethical approval for the study was obtained from the Gazi University Non-Interventional Clinical Research Ethics Committee (Decision date: December 21, 2020; Approval number: 2020/21-876). Written informed consent was obtained from the parents of all participants prior to participation in the study.

Statistical Analysis

Nominal and ordinal data were summarized using frequencies, while continuous variables were expressed as mean values and standard deviations. Fisher's Exact test was used to analyze differences in nominal and ordinal variables. Since the measurement data were not normally distributed, non-parametric statistical tests were applied. The Mann-Whitney U test was used to compare differences between the two groups. Spearman's rho correlation analysis was performed to evaluate correlations between variables. The Wilcoxon signed-rank test was used to analyze within-group differences between pre- and post-intervention measurements. All statistical analyses were performed using SPSS software (version 17.0; SPSS Inc., Chicago, IL, USA), and a 95% confidence interval was accepted as statistically significant.

Results

In this study, 23 (13.74±1.86 years) adolescents with Idiopathic Scoliosis were homogeneously divided into two groups as Schroth exercise group (EG, n=12) and the combined group (CG, n=11) based on the pretest values. Demographic characteristics of the individuals are listed in Table 1. There were no statistically significant differences between groups ($p>0.05$). Baseline values of quality of life, visual perception, gibbosity, static and dynamic balance in both groups were also similar ($p>0.05$) except for WRVAS scores, in which the combined group was significantly higher than the exercise group ($p<0.05$).

Table 1. Physical properties of the study groups.

Characteristics	Exercise Group (n=12)	Combined Group (n=11)	P-value
Age (years), mean (SD)	13.17±1.90	14.36±1.69	0.069
Height (cm), mean (SD)	159.83±10.09	162.73±8.05	0.347
Weight (kg), mean (SD)	46.67±12.74	49.55±10.35	0.413
BMI (kg/m ²), mean (SD)	18.09±3.64	18.64±3.18	0.740
Female / male, n (%)	8 (66.7) / 4 (33.3)	7 (63.6) / 4 (36.4)	0.611

BMI: Body mass index; SD: Standard deviation.

Table 2 demonstrates pre-treatment and post-treatment values, within-group and between-group comparison of SRS-22, WRVAS, gibbosity, Stork and Y-balance test scores. Quality of life, except SRS-22 function value for the combined group, showed a nonsignificant change in both groups ($p>0.05$). Visual perception and gibbosity scores improved significantly in both groups at 12 weeks ($p<0.05$). Both Stork scores in the exercise group and the left lower limb Stork score were similar at 12 weeks of intervention ($p>0.05$). In the combined group, Stork measurement taken from the right lower limb revealed statistically significant improvement ($p=0.041$). Combined group showed a nonsignificant increase in all of the Y-Balance test measurements 12 weeks post-treatment ($p>0.05$). In the exercise group, Y-Balance test measurements of right anterior, right posteromedial, left posterolateral, left posteromedial, composite right, and composite left showed statistically significant improvement in dynamic balance compared with pre-treatment values ($p<0.05$). No statistically significant differences between groups were detected for all the outcomes ($p>0.05$) (Table 2).

Table 2. Pre-treatment and post-treatment values (mean (SD)), within-group and between-group comparison of quality of life, visual perception, gibbosity, static and dynamic balance.

Outcome variable	Exercise Group (n=12)			Combined Group (n=11)			Between-group P-value
	Pre-treatment mean (SD)	Post-treatment mean (SD)	Within-group P-value	Pre-treatment mean (SD)	Post-treatment mean (SD)	Within-group P-value	
SRS-22							
Pain	22.33±2.61	23.25±1.91	0.180	22.55±2.81	23.18±1.99	0.221	0.342
Image	17.58±3.18	18.50±3.73	0.194	17.36±3.32	17.73±2.24	0.670	0.312
Function	23.67±1.15	24.00±0.95	0.157	23.09±1.70	24.36±0.67	0.048	0.247
Mental Health	19.08±3.53	19.17±4.67	0.833	18.36±4.86	20.18±3.74	0.190	0.417
Treatment Satisfaction	8.83±1.27	9.08±0.67	0.582	9.55±0.69	9.27±1.01	0.257	0.543
SRS-22 Total	91.50±7.14	94.00±8.09	0.222	90.91±11.40	94.73±6.74	0.266	0.614
WRVAS							
Own	12.42±1.56	9.92±1.68	0.007	15.91±3.42	13.82±4.09	0.028	0.321
Family	11.92±3.18	9.58±2.54	0.011	16.45±4.89	13.36±4.32	0.035	0.457
Gibbosity	4.00±3.36	2.75±2.73	0.007	6.64±2.66	4.73±3.00	0.016	0.211
Stork							
Right	4.21±2.60	5.24±4.15	0.388	3.08±1.22	4.63±2.52	0.041	0.242
Left	4.51±3.11	5.19±3.38	0.530	3.16±1.19	3.61±2.14	0.722	0.351
Y-Balance (Reach Distance / Leg Length)							
Anterior (R)	0.67±0.07	0.69±0.07	0.002	0.68±0.07	0.70±0.07	0.074	0.082
Posterolateral (R)	0.77±0.11	0.85±0.11	0.071	0.82±0.13	0.84±0.13	0.859	0.267
Posteromedial (R)	0.83±0.27	0.96±0.09	0.015	0.95±0.07	0.97±0.07	0.155	0.074
Anterior (L)	0.66±0.08	0.67±0.07	0.638	0.62±0.13	0.69±0.06	0.059	0.202

Posterolateral (L)	0.74±0.15	0.82±0.17	0.010	0.77±0.14	0.83±0.11	0.075	0.060
Posteromedial (L)	0.93±0.11	0.95±0.12	0.041	0.84±0.29	0.97±0.07	0.050	0.064
Composite (R)	78.83±7.33	83.39±8.95	0.023	81.71±7.07	83.67±6.50	0.155	0.081
Composite (L)	77.68±10.53	81.26±11.7	0.012	78.68±7.41	83.23±6.01	0.050	0.094

L: Left; R: Right; SD: Standard deviation; SRS-22: Scoliosis Research Society-22; WRVAS: Walter Reed Visual Rating Scale

Discussion

The present study aimed to compare the effects of the Schroth exercise method alone and the Schroth exercise method combined with manual therapy on gibbosity angle, visual perception of trunk deformity by the participant and family, static balance, dynamic balance, and quality of life in adolescents with idiopathic scoliosis.

Although numerous studies have investigated different treatment approaches for scoliosis, relatively few studies have examined the specific effects of manual therapy on parameters such as gibbosity angle, trunk deformity perception, and balance performance. Therefore, the current study aimed to contribute to the literature by investigating whether the addition of manual therapy to a Schroth-based exercise program provides additional benefits in adolescents with idiopathic scoliosis.

Baseline demographic characteristics such as gender distribution, age, height, and body mass index were comparable between the two groups, suggesting that the groups were similar prior to the intervention. Previous studies have reported that the progression of scoliosis during adolescence is closely associated with skeletal maturation, and commonly used indicators include chronological age, Risser sign, and age at menarche². In addition, the incidence and risk of progression of scoliosis have been reported to be approximately three to five times higher in females than in males². The similar demographic distribution between the groups in the present study supports the comparability of the study population.

Quality of life outcomes assessed using the SRS-22 questionnaire were slightly higher in the combined intervention group compared with the exercise-only group, although these differences were not statistically significant. Reichel and Schanz²⁵ reported that the negative perception of body image associated with scoliosis can significantly influence quality of life and that improvements in spinal curvature may lead to improvements in patient perception and quality of life. In the present study, although visual perception scores appeared to be higher in the combined intervention group, the absence of statistically significant differences between the groups suggests that these findings should be interpreted cautiously.

Similarly, visual perception of trunk deformity assessed using the WRVAS scale was higher in the combined intervention group. Manual therapy techniques such as mobilization and manual corrective pressures may theoretically influence proprioceptive

feedback and postural awareness. However, the results of the present study do not provide strong evidence confirming a direct causal relationship between manual therapy and improvements in visual perception. Therefore, further controlled studies are required to clarify the potential role of manual therapy in influencing cosmetic perception in adolescents with scoliosis.

Regarding balance performance, no statistically significant differences were observed between the groups in either static or dynamic balance parameters following the intervention. Nevertheless, improvements were observed in several balance measures in both groups. Previous studies have reported that postural control and proprioceptive mechanisms may be affected in individuals with idiopathic scoliosis^{6,26}. The Schroth method is one of the most widely studied physiotherapeutic scoliosis-specific exercise (PSSE) approaches and includes fundamental principles such as postural stabilization, trunk alignment, and proprioceptive training¹⁸. Therefore, improvements observed in balance performance in both groups may be related to the neuromuscular training components of the Schroth exercise program.

Although greater reductions in gibbosity values were observed in the combined intervention group compared with the exercise group, the differences between the groups were not statistically significant. While manual corrective pressures applied during manual therapy may theoretically contribute to improved spinal mobility and trunk symmetry, the findings of the present study do not provide clear evidence supporting a superior effect of manual therapy. A case report describing a 15-year-old female with thoracic scoliosis reported a reduction in gibbosity angle following a three-month manual therapy intervention²⁷. However, findings from individual case reports should be interpreted cautiously and cannot be generalized to larger clinical populations.

Another factor that may influence scoliosis progression is body composition. Previous studies have suggested that individuals with low leptin levels may have an increased risk of scoliosis²⁸. In addition, Tekgöl et al.²⁹ reported that BMI values between 20–25 kg/m² are considered normal for adolescents. The relatively low BMI values observed in the present study population are consistent with findings reported in previous studies.

Several limitations of the present study should be considered when interpreting the results. First, the relatively small sample size may have limited the statistical power to detect significant differences between the groups. Second, participants were allocated according to the order of admission rather than through randomization, which may introduce potential selection bias. Third, blinding of participants and therapists was not feasible due to the nature of the intervention, and outcome assessments were conducted by the same physiotherapist, which may increase the risk of measurement bias. Furthermore, although the intervention period lasted three months, longer follow-up periods may be necessary to evaluate structural changes in spinal deformity in adolescents with idiopathic scoliosis.

Future studies with larger sample sizes, randomized controlled designs, and longer follow-up periods are required to better understand the potential additive effects of

manual therapy when combined with physiotherapeutic scoliosis-specific exercises. Despite these limitations, the findings of the present study suggest that Schroth-based exercise programs may contribute to improvements in trunk deformity perception, balance performance, and quality of life in adolescents with idiopathic scoliosis. However, further high-quality studies are required to determine whether the addition of manual therapy provides clinically meaningful additional benefits.

Conclusion

In this study, no difference was found between the exercise and combined groups in terms of static and dynamic balance, gibbosity and quality of life except for the visual perception evaluation parameter. Although gibbosity and quality of life values were higher in the combined group than in the exercise group and static balance was better in the exercise group, there was no statistically significant difference between the two groups.

In future studies, women and men can be evaluated in separate groups due to different physiological characteristics and different maturation processes, and individuals can be categorized according to their daily physical activity levels. With larger sample sizes and longer follow-up periods, more significant and reliable results may be obtained in the combined treatment group for degree of gibbosity, quality of life and static-dynamic balance. Further studies are required to explore the continuity of the positive results obtained with the two treatment methods in this study.

Ethical Approval: The protocol was approved by the Non-Interventional Clinical Research Ethics Committee of the Gazi University, Türkiye (Number: 2020/21-876, Date: 21.12.2020). Informed consent was obtained from all participants.

Funding: The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing Interests: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. Hakkert AM. Hippocrates: On Nature of Bones. In: Littre PE, editor. *Oeuvres Completes d'Hippocrate*. Amsterdam; 1982.
2. Sanders JO, Browne RH, McConnell SJ, Margraf SA, Cooney TE, Finegold DN. Maturity assessment and curve progression in girls with idiopathic scoliosis. *J Bone Joint Surg Am*. 2007;89(1):64–73.
3. Bilgiç S, Erşen Ö. Adolesan idiyopatik skolyoz konservatif tedavisi. *Türkiye Klinikleri J Orthop Traumatol-Special Topics*. 2017;10(2):118–123.

4. Lowe TG, Edgar M, Margulies JY, Miller NH, Raso VJ, Reinker KA, et al. Etiology of idiopathic scoliosis: current trends in research. *J Bone Joint Surg Am*. 2000;82(8):1157–1168.
5. Karanki İ. Body image and self-esteem levels in girls adolescents with idiopathic scoliosis and their effects on quality of life and compliance to treatment [master's thesis]. Istanbul: Halic University, Institute of Health Sciences; 2016.
6. Gür G. Investigation of the effect of spinal stabilization training and body awareness training on subjective vertical perception and body symmetry in adolescent idiopathic scoliosis [doctoral thesis]. Ankara: Hacettepe University, Institute of Health Sciences; 2015.
7. Haumont T, Gauchard GC, Lascombes P, Perrin PP. Postural instability in early-stage idiopathic scoliosis in adolescent girls. *Spine*. 2011;36(13): E847–E854.
8. Massion J. Postural control system. *Curr Opin Neurobiol*. 1998;8(6):746–751.
9. Lion A, Gauchard GC, Barrault D, Perrin PP. Differentiated postural control strategies in young and elderly subjects suffering from severe visual impairment. *Age*. 2013;35(3):717–726.
10. Sahlstrand T, Örtengren R, Nachemson A. Postural equilibrium in adolescent idiopathic scoliosis. *Acta Orthop Scand*. 1978;49(4):354–365.
11. Bisdorff A, Anastasopoulos D, Bronstein A, Gresty M. Subjective postural vertical in peripheral and central vestibular disorders. *Acta Otolaryngol Suppl*. 1995;(520):68–71.
12. Korovessis P, Kyrkos C, Piperos G, Soucacos PN. Effects of thoracolumbosacral orthosis on spinal deformities, trunk asymmetry, and frontal lower rib cage in adolescent idiopathic scoliosis. *Spine*. 2000;25(16):2064–2071.
13. Dixit S, Agarwal G, Singh J, Kant S, Singh JV. A study on consciousness of adolescent girls about their body image. *Indian J Community Med*. 2011;36(3):197–202.
14. Pineda S, Bago J, Gilperez C, Climent JM. The Walter Reed Visual Assessment Scale: a valid and reliable tool for evaluating adolescents with idiopathic scoliosis. *J Pediatr Orthop*. 2006;26(2):202–206.
15. Bago J, Sanchez-Raya J, Perez-Grueso FJ, Climent JM. The Trunk Appearance Perception Scale (TAPS): a new tool to evaluate subjective impression of trunk deformity in patients with idiopathic scoliosis. *Scoliosis*. 2010; 5:6.
16. Savaş S. Scoliosis and treatment methods. *J Clin Orthop Trauma*. 2003;13(2):105–112.

17. Park JH, Jeon HS, Park HW. Effects of the Schroth exercise on idiopathic scoliosis: a systematic review. *Eur Spine J.* 2017;26(3):593–602.
18. Lehnert-Schroth C. *Three-Dimensional Treatment for Scoliosis: A Physiotherapeutic Method for Deformities of the Spine.* Palo Alto (CA): Martindale Press; 1992.
19. Çolak TK, Akgül T, Budak FA, Uzel M, Çetin E, Erşen Ö. The impact of Schroth exercises on postural control in adolescents with idiopathic scoliosis: an experimental study. *Spine J.* 2020;20(2):216–223.
20. Franko OI, Bray C, Newton PO. Validation of a scoliometer smartphone app to assess scoliosis. *J Pediatr Orthop.* 2012;32(8): e72–e75.
21. Panta KP. The reliability of the Standing Stork Test for assessing static balance: a comparison study. *J Phys Ther Sci.* 2015;27(4):1239–1242.
22. Bahar Z. Dynamic balance performance and non-dominant leg advantage in elite athletes. *Percept Mot Skills.* 2019;126(5):873–885.
23. Engquist KD, Smith CA, Chimera NJ, Warren M. Performance comparison on the Y-Balance Test between high school and collegiate athletes. *J Strength Cond Res.* 2015;29(11):3173–3179.
24. Alanay A, Cil A, Berk H, Acaroglu E, Yazici M, Akcali O, et al. Reliability and validity of the adapted Turkish version of the Scoliosis Research Society-22 (SRS-22) questionnaire. *Spine.* 2005;30(21):2464–2468.
25. Reichel D, Schanz J. Developmental psychological aspects of scoliosis treatment. *Pediatr Rehabil.* 2003;6(3–4):221–225.
26. Assaiante C, Mallau S, Jouve JL, Bollini G, Vaugoyeau M. Do adolescent idiopathic scoliosis (AIS) neglect proprioceptive information in sensory integration of postural control? *PLoS One.* 2012;7(7): e40646.
27. Chen KC, Chiu EH. Adolescent idiopathic scoliosis treated by spinal manipulation: a case study. *J Altern Complement Med.* 2008;14(6):749–751.
28. Tam EMS, Liu Z, Lam TP, et al. Lower muscle mass and body fat in adolescent idiopathic scoliosis are associated with abnormal leptin bioavailability. *Spine (Phila Pa 1976).* 2016;41(11):940–946.
29. Tekgöl N, Dirik N, Karademirci E, Doğan A. Adolesanlarda vücut kitle indeksi ile ilişkili değişkenlerin incelenmesi. *Ege Tıp Dergisi.* 2012;51(3):183–186.

Health Perceptions and Attitudes Toward Cancer Screenings Among Individuals Attending Family Health Centers: A Cross-Sectional Research

Dilek YILDIRIM*, Ferda AKYÜZ ÖZDEMİR**, İbrahim Halil BOYACI***

Abstract

Aim: This study aimed to investigate the effect of individuals' health perceptions on their attitudes toward cancer screening and to examine the relationship between these two variables.

Method: We implemented a descriptive, cross-sectional, and correlational design. The sample consisted of 351 adults who applied to a family health center in Muğla, Turkey, between January and August 2025. Data were collected using a Personal Information Form, the Health Perception Scale, and the Attitude Scale for Cancer Screening. Statistical analyses included descriptive tests, independent samples t-tests, Pearson correlation, and regression analysis.

Results: The mean age of participants was 43.4±13.9 years, and 60.1% had never undergone cancer screening. The average scores were 38.17±8.21 on the Health Perception Scale and 74.64±15.89 on the Attitude Scale for Cancer Screening. A significant positive correlation was found between health perception and attitudes toward cancer screening ($r=0.350$, $p<0.001$). Regression analysis demonstrated that health perception explained 12.3% of the variance in screening attitudes. Participants with knowledge about cancer or screening methods had significantly higher health perception scores ($p<0.05$). No significant differences were observed in screening attitudes by gender, age, or chronic disease status.

Conclusion: The findings indicate that health perception is a key determinant of attitudes toward cancer screening. Interventions that strengthen health literacy, enhance awareness, and reduce psychosocial barriers could increase participation in screening programs. Educational initiatives and support interventions delivered through family health centers may play an essential role in promoting early detection and improving community health outcomes.

Keywords: Health perception, cancer screening, attitude, family health center, nursing.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 25.09.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1790889>

* Assoc. Prof., Istanbul Aydın University, Faculty of Health Sciences, Department of Nursing, Istanbul, Türkiye.

E-mail: dilekyildirim@aydin.edu.tr ORCID <https://orcid.org/0000-0002-6228-0007>

** Asst. Prof., Muğla Sıtkı Koçman University, Fethiye Faculty of Health Sciences, Department of Internal Medicine Nursing, Muğla, Türkiye. E-mail: ferdaakyuz@mu.edu.tr ORCID <https://orcid.org/0000-0001-9109-3692>

*** Republic of Türkiye, Ministry of Health, Fethiye District Health Directorate - Fethiye Family Health Center No. 3, Fethiye Family Medicine Unit No. 21, Muğla, Türkiye. E-mail: kardox73@gmail.com ORCID <https://orcid.org/0009-0009-8061-9025>

ETHICAL STATEMENT: Ethical approval for the study was obtained from the Ethics Committee of Istanbul Aydın University (Date-form number: 25.12.2024; 136/2024). Informed consent was obtained from all participants.

Aile Sağlığı Merkezine Başvuran Bireylerin Sağlık Algıları ve Kansere Taramalarına Yönelik Tutumları

Öz

Amaç: Bu araştırma, bireylerin sağlık algılarının kanser taramalarına yönelik tutumları üzerindeki etkisini ve bu iki değişken arasındaki ilişkinin belirlenmesi amacıyla yapılmıştır.

Yöntem: Tanımlayıcı, kesitsel ve ilişki arayıcı tipteki araştırma Ocak–Ağustos 2025 tarihleri arasında Muğla’da bir aile sağlığı merkezine başvuran 351 kişi ile yürütülmüştür. Veriler, Kişisel Bilgi Formu, Sağlık Algısı Ölçeği ve Kansere Taramasına Yönelik Tutum Ölçeği kullanılarak toplanmıştır.

Bulgular: Katılımcıların yaş ortalaması $43,42 \pm 13,90$ ’dır. Katılımcıların %60,1’i daha önce hiç kanser taraması yaptırmamıştır. Sağlık algısı ve kanser taramasına yönelik tutum arasında pozitif yönlü anlamlı bir ilişki saptanmıştır ($r=0,350$; $p < 0,001$). Regresyon analizine göre sağlık algısı, tutum puanlarındaki varyansın %12,3’ünü açıklamaktadır. Kansere konusunda bilgi sahibi olan bireylerin sağlık algısı puanları anlamlı düzeyde daha yüksektir ($p=0,021$).

Sonuç: Bulgular, sağlık algısının kanser taramasına yönelik tutumları olumlu yönde etkilediğini göstermektedir. Aile sağlığı merkezlerinde uygulanacak eğitim programları, farkındalık çalışmaları ve psikososyal destek müdahaleleri, kanser tarama programlarına katılımı artırmada önemli katkı sağlayabilir.

Anahtar Sözcükler: Sağlık algısı, kanser taraması, tutum, aile sağlığı merkezi, hemşirelik.

Introduction

The health perceptions and attitudes toward cancer screening of individuals applying to Family Health Centers stand out as a significant public health concern. Cancer is one of the leading causes of morbidity and mortality worldwide and constitutes a major burden on healthcare systems, societies, and economies. The increasing incidence and mortality rates of cancer make it a critical public health priority that requires effective prevention and early detection strategies. Health perception represents a fundamental determinant in how individuals evaluate their own health status and in shaping their attitudes toward healthcare services¹. These perceptions can have a direct impact on both the accessibility of healthcare services and the regularity of their use by individuals². Cancer screening services, in particular, play a pivotal role in the early detection of disease. Therefore, given that attitudes toward these services are closely linked to individuals’ health perceptions^{3,4}. For instance, implementing public campaigns aimed at educating the community about the importance of cancer screenings, raising awareness, and facilitating access to such services are seen as a critical strategy⁵.

Family Health Centers serve as key healthcare providers addressing a wide range of individual health needs. These centers also enable the provision of screening services for serious health conditions such as cancer⁶. Given the high global burden of cancer, primary care settings such as Family Health Centers play a crucial role in reducing cancer-related morbidity and mortality through early diagnosis and timely intervention. It is reported that the psychosocial needs of patients, especially those related to cancer diagnosis, have the potential to directly affect their general health status and quality of

life. Numerous studies have indicated that the psychosocial challenges experienced by cancer patients emerge as a significant risk factor throughout the course of treatment^{7,8}. Therefore, it is important to emphasize that health perception is closely associated not only with physical health but also with psychosocial well-being⁹.

Attitudes toward cancer screening are among the key factors influencing individuals' participation in screening services. Research has shown that these attitudes are directly associated with the overall health perceptions of the community¹⁰. Despite the proven effectiveness of screening programs in reducing cancer-related mortality, participation rates remain suboptimal in many populations, which further underscores the importance of understanding the factors that influence these attitudes. For example, studies conducted in countries such as Korea demonstrate an increasing tendency among individuals to adopt a positive attitude toward screening services^{11,12}. These attitudes are closely linked not only to the accessibility of healthcare services but also to individuals' levels of health education. Consequently, factors influencing women's participation in specific screening programs, such as breast cancer screening, include both their health perceptions and the availability of psychosocial support^{13,14}.

Efforts to enhance health perceptions in society and to expand access to screening services are also supported by government policies. Various health organizations conduct campaigns to inform the public about the importance of health screenings and implement initiatives aimed at strengthening social trust to increase the effectiveness of these campaigns¹⁵. Addressing cancer as a societal issue requires coordinated actions at individual, community, and policy levels. In addition, barriers to accessing cancer screening services should be taken into account. In particular, limited access for individuals living in rural areas further exacerbates health inequalities^{12,16}. This situation leads to variability in cancer screening attitudes across different segments of the population, thereby representing a dynamic that broadly influences the healthcare system¹⁷.

The health perceptions and attitudes toward cancer screening among individuals attending Family Health Centers involve the interaction of multiple health-related variables. This interplay not only facilitates participation in cancer screening services but also highlights the impact of health perception on public health¹⁸. Therefore, studies conducted in this area will make a significant contribution to a better understanding of individuals' health perceptions and attitudes toward screening^{19,20}. Raising awareness on these issues within the community is essential for fostering healthier individuals and, consequently, healthier societies.

In conclusion, individuals' health perceptions and attitudes toward cancer screening represent complex dynamics that influence public health. Considering these factors in healthcare delivery is critical for enhancing the efficiency of the health system and improving community health. In this context, efforts to promote health education and raise societal awareness can strengthen preventive health services and facilitate the implementation of more effective screening programs. From this perspective, the present

study was conducted to determine the health perceptions and attitudes toward cancer screening among individuals attending Family Health Centers.

Material and Methods

Design

This study was conducted using a descriptive, cross-sectional, and correlational design. It was completed between January 2025 and August 2025 with the participation of 351 individuals to determine the health perceptions and attitudes toward cancer screening among those attending Family Health Centers. The study was reported in accordance with 'the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement'.

Population and Sampling

The study population consisted of adult individuals receiving treatment and follow-up at a Family Health Center in Muğla. Participants were recruited exclusively from this center. A non-probability sampling method, specifically the snowball sampling technique, was employed within the study setting. Initially, eligible participants who attended the Family Health Center were invited to participate in the study. These participants were then asked to recommend other individuals from the same center who met the inclusion criteria, allowing the sample to expand through a chain-referral process. Individuals aged 18 years and older, willing to participate in the study, and without any communication difficulties were included. Those with previously diagnosed psychiatric disorders were excluded. A post hoc power analysis was conducted using G*Power (version 3.1.9.7) to evaluate the statistical power of the study sample. The significance level (α) was set at 0.05. Assuming a medium effect size ($d=0.50$), the total sample size of 351 patients yielded a statistical power of greater than 95%.

Data Collection

Data for the study were collected between January and August 2025 from adult individuals receiving treatment and follow-up at a Family Health Center in Muğla. Participants were informed about the study objectives in the patient room, and verbal consent was subsequently obtained. They were assured that they could withdraw from the study at any time and that all collected data would be kept confidential. Data were gathered using a Personal Information Form, the Health Perception Scale, and the Attitude Scale for Cancer Screening. The administration took approximately 20–25 minutes, allowing participants sufficient time to respond carefully to the questions, thereby supporting the validity and reliability of the collected data. At the end of the data collection process, participants received thanks for their contribution to the study.

Instruments

The study's data were collected using a personal information form, the health perception scale and the attitude scale for cancer screening.

Personal Information Form

The form assessed participants' socio-demographic characteristics (marital status, gender, place of residence, age, education level), health history (smoking and alcohol use, presence of chronic diseases, personal history of cancer, and occurrence of cancer among first-, second-, or third-degree relatives), as well as their knowledge about cancer and attitudes toward cancer screening (awareness of cancer, being informed about cancer screenings, and history of undergoing screening). The form consisted of a total of 16 questions. This form was developed by the researchers based on information available in the literature^{2,7,21}.

Attitude Scale for Cancer Screening

The Attitude Scale for Cancer Screening was developed by Yıldırım, Öztürk, and colleagues (2020), Which its has confirmed validity and reliability for the Turkish language²². The scale consists of 24 items and a single dimension, using a five-point Likert-type response format. Items are scored on a scale from 1 to 5 as follows: '5: Strongly agree, 4: Agree somewhat, 3: Neither agree nor disagree, 2: Disagree somewhat, 1: Strongly disagree.' The administration of the scale should be conducted in such a way that the researcher observes the participant while the participant independently reads and responds to the items. With an appropriate sample and administration method, the scale can be used whenever measurement of attitudes toward cancer screening is required. The total score ranges from 24 to 120, with no predefined cut-off point. Scores closer to 24 indicate a more negative attitude toward cancer screening, whereas scores approaching 120 reflect a more positive attitude. In the validity and reliability study, the scale demonstrated a Cronbach's alpha of 0.95²². In this study, it was found as 0.88.

Health Perception Scale

The Health Perception Scale was developed by Diamond and colleagues in 2007²³. Its Turkish validity and reliability were established by Kadioğlu and Yıldız in 2012²⁴. Health Perception Scale: The Health Perception Scale consists of 15 items and four subdimensions (Certainty, Locus of Control, Self-Awareness, and Importance of Health) and uses a five-point Likert-type response format. Possible scores on the scale range from 15 to 75. A high score indicates a high perception of health, while a low score indicates a low perception of health. The original validity and reliability study of the scale showed a Cronbach's alpha value of 0.77²⁴, for this study, it was found as 0.78.

Data Analysis

Data obtained from the study were analyzed using SPSS 26.0. Normal distribution of the data was determined using the Kolmogorov-Smirnov test. Descriptive statistics were used in the study, independent sample t-tests were used to examine differences between groups, and Pearson correlation analyses were used to assess the relationship between health perception and attitudes toward cancer screening. Correlation tests were used to determine the relationship between variables.

Ethical Approval

The study was conducted with the approval of the Non-Interventional Clinical Research Ethics Committee of Istanbul Aydın University (Date: December 25, 2024; Decision No: 136/2024). During data collection, personally identifiable information such as names and surnames was not recorded, and all data were analyzed anonymously. The research was carried out in accordance with the ethical principles outlined in the 'Declaration of Helsinki'.

Results

The mean age of the participants was 43.42 ± 13.90 years. The majority of the participants were female (59.8%). Most individuals reported having an income equal to their expenses (62.1%). In terms of educational level, the largest proportion had a university degree or higher (35.3%). Regarding occupational status, workers constituted the largest group (26.8%).

A considerable majority of participants did not engage in regular exercise (78.6%). Similarly, most participants reported not smoking (65.2%) and not consuming alcohol (81.8%) (Table 1).

Table 1. Socio-Demographic Characteristics of Patients (n=351)

Characteristics	Mean	SD
Age (Years)	43.421	13.908
	n	%
Gender		
Female	210	59.8
Male	141	40.2
Economic Status		
Income < expenses	102	29.1
Income = expenses	218	62.1
Income > expenses	31	8.9
Occupation		
Civil Servant	54	15.4
Retired	78	22.2
Worker	94	26.8
Housewife	69	19.7
Student	12	3.4
Unemployed	44	12.6

Education Level		
Literate	12	3.4
Primary School	66	18.8
Middle School	48	13.7
High School	101	28.8
University or above	124	35.3
Alcohol Consumption		
Yes	64	18.2
No	287	81.8
Smoking		
Yes	122	34.8
No	229	65.2
Regular Exercise Status		
Yes	75	21.4
No	276	78.6

Of the participants, 40.2% had a diagnosed chronic disease, compared to 59.8% did not have any chronic conditions. Regarding types of chronic diseases, the breakdown showed 9.4% hypertension, 4.6% thyroid disorders, 10.3% asthma, 9.1% diabetes mellitus, 6.8% heart disease, 1.4% COPD, 2.8% psychiatric disorders, and 10.6% a cancer diagnosis. More than half of the participants reported not having a family member or someone in their social circle diagnosed with cancer (56.4%). A majority stated that they were informed about cancer (67.5%); however, most participants reported a lack of knowledge regarding cancer screening (57.6%). A considerable proportion of participants had never undergone any cancer screening (60.1%). Among screening methods, mammography (12.9%) and Pap smear (10.5%) were the most commonly reported. Health professionals were identified as the primary source of cancer-related information (37.9%), followed by relatives or close social circles (18.8%) (Table 2).

Table 2. Diagnosis and Treatment Characteristics of Patients (n=351)

Characteristics	Mean n	SD %
Chronic Disease Status		
Yes	141	40.2
No	210	59.8
Chronic Disease Diagnosis*		
Hypertension	33	9.4
Thyroid Diseases	16	4.6
Asthma	36	10.3
Diabetes Mellitus	32	9.1
Heart Diseases	24	6.8
COPD	5	1.4
Psychiatric Diseases	10	2.8
Cancer	37	10.6
Having a family member or social circle diagnosed with cancer		
Yes	153	43.6
No	198	56.4

Being Informed About Cancer Diagnosis		
Yes	237	67.5
No	114	32.5
Cancer Screening Information		
Yes	149	42.4
No	202	57.6
Cancer Screening Information		
Yes	140	39.9
No	211	60.1
Cancer Screenings Performed*		
Breast Ultrasound	15	4.3
Colonoscopy	15	4.3
Pap Smear	37	10.5
HPV Screening	5	1.5
Mammography	45	12.9
Fecal Occult Blood Test	26	7.4
Cancer Information Sources*		
Healthcare Professionals (Doctors, Nurses)	133	37.9
Social Media	65	18.5
Relatives	66	18.8
I am a healthcare professional myself	13	3.7
Internet	41	11.7

* **Marked more than once.**

The mean score of the participants on the Attitude Scale for Cancer Screening was 74.64 ± 15.89 . The total mean score on the Health Perception Scale was 38.17 ± 8.21 . Regarding the subdimensions of the Health Perception Scale, the mean scores were as follows: Locus of Control, 15.20 ± 5.33 ; Self-Awareness, 6.47 ± 1.99 ; Certainty, 10.75 ± 3.46 ; and Importance of Health, 5.74 ± 1.83 (Table 3).

Table 3. Patients' Health Perception Scale and Attitude Scale for Cancer Screening (n=351)

Scales	Mean	SD	Min-Max
Attitude Scale for Cancer Screening	74.64	15.89	24-120
Health Perception Scale	38.17	8.21	15-58
Control Center Subscale	15.20	5.33	5-25
Self-Awareness Subscale	6.47	1.99	3-12
Certainty Subscale	10.75	3.46	4-20
Importance of Health Subscale	5.74	1.83	3-12

When examining the relationships between scale scores in the study, a significant positive correlation was found between the total scores of the Attitude Scale for Cancer

Screening and the Health Perception Scale ($r=0.350$, $p<0.001$). Significant positive correlations were also observed between attitudes toward cancer screening and the subdimensions of the Health Perception Scale: Locus of Control ($r=0.285$, $p=0.001$), Self-Awareness ($r=0.177$, $p=0.001$), Certainty ($r=0.205$, $p<0.001$), and Importance of Health ($r=0.160$, $p=0.003$). The total score of the Health Perception Scale demonstrated strong and significant correlations with all its subdimensions (Locus of Control $r=0.844$; Self-Awareness $r=0.331$; Certainty $r=0.702$; Importance of Health $r=0.336$; all $p<0.001$). Additionally, the subdimensions exhibited significant correlations with each other at varying levels. On the other hand, no statistically significant relationship was found between age and any of the scale scores ($p>0.05$) (Table 4).

Table 4. Correlation analysis results (n=351)

		1.	2.	3.	4.	5.	6.
1. Attitude Scale for Cancer Screening	r	1					
	p						
2. Health Perception Scale	r	0.350	1				
	p	<0.001					
3. Control Center Subscale	r	.285	.844	1			
	p	.001	<0.001				
4. Self-Awareness Subscale	r	.177	.331	-.008	1		
	p	.001	<0.001	.885			
5. Certainty Subscale	r	.205	.702	.434	.024	1	
	p	<0.001	<0.001	<0.001	.653		
6. Importance of Health Subscale	r	.160	.336	.058	.368	-.036	1
	p	.003	<0.001	.275	<0.001	.505	
7. Age (years)	r	.011	-.044	-.072	-.079	.090	-.070
	p	.841	.442	.187	.143	.098	.197

* $p<0.05$ ** $p<0.01$; Pearson correlation test.

When participants' scale scores were examined according to certain socio-demographic and health characteristics, no significant differences were found between genders for the Health Perception Scale (female: 38.43 ± 7.79 , male: 37.77 ± 8.84 ; $p=0.458$) or the Attitude Scale for Cancer Screening (female: 74.68 ± 8.71 , male: 74.52 ± 13.53 ; $p=0.868$). Mean scores of both scales were similar between individuals with and without chronic diseases ($p>0.05$). Although participants with a family or social contact diagnosed with cancer had higher health perception scores (39.03 ± 7.38), this difference was not statistically significant ($p=0.089$). Participants who reported having knowledge about cancer had significantly higher health perception scores (38.91 ± 8.21) compared to those without such knowledge (36.75 ± 7.98 ; $p=0.021$). Similarly, participants knowledgeable about cancer screenings had higher health perception scores (39.41 ± 7.96) than those without knowledge, and this difference was statistically significant ($p=0.015$). In contrast, no significant differences were observed in attitudes toward cancer screening based on these variables ($p>0.05$), (Table 5).

Table 5. Mean Scores of Health Perception and Attitudes for Cancer Screening According to Certain Participant Characteristics (n=351)

Characteristics		Health Perception Scale	Attitude Scale for Cancer Screening Scale
		Mean±SD	Mean±SD
Gender			
	Female	38.438±7.792	74.682±8.717
	Male	37.771±8.840	74.522±13.530
t		.743	.166
p		.458	.868
Chronic Disease Status	Yes	38.446±7.884	73.595±14.692
	No	38.000±8.437	75.347±16.654
t		.499	-1.012
p		.618	.312
Having a family member or social circle diagnosed with cancer	Yes	39.033±7.384	75.666±13.678
	No	37.520±8.777	73.762±17.433
t		1.703	1.105
p		.089	.270
Being Informed About Cancer Diagnosis	Yes	38.915±8.215	75.063±15.345
	No	36.752±7.982	73.938±17.006
t		2.324	.619
p		0.021	0.536
Cancer Screening Information	Yes	39.416±7.969	73.718±14.290
	No	37.255±8.323	75.125±16.772
t		2.443	-0.825
p		0.015	.410

t=t-Test.

According to the regression analysis results presented in Table 6, the total score of the Health Perception Scale significantly predicted the total score of the Attitude Scale for Cancer Screening ($R = 0.350$, $R^2 = 0.123$, Adjusted $R^2 = 0.120$, $F = 48.808$, $p < 0.001$). These findings indicate that an increase in individuals' health perception is associated with the development of more positive attitudes toward cancer screening. Approximately 12.3% of the variance in attitude scores toward cancer screening is explained by health perception. Examination of the regression coefficients revealed that health perception has a positive and significant effect on attitude ($\beta = 0.350$, $p < 0.001$). Additionally, the Durbin-Watson statistic was 1.998, indicating that there was no autocorrelation problem in the model (Table 6).

Table 6. The Effect of Individuals' Health Perception on Their Attitudes for Cancer Screening (n=351)

	B	Standard Error	Standard Beta (β)	t	p	95.0% CI	
Constant	48.754	3.790		12.862	.000	41.299	56.208
Health Perception Scale Total Score	.678	.097	.350	6.986	.000	.487	.869
Dependent Variable: Attitude Scale for Cancer Screening Scale Total Score							
R=0.350, R ² =0.123, Adjusted R ² =0.120, F=48.808, p<0.001, Durbin Watson=1.998 (1.5-2.5)							

Discussion

This study examined the relationship between health perception and attitudes toward cancer screening among individuals attending a family health center and found that health perception significantly predicted screening attitudes. The findings indicate that higher levels of health perception are associated with more positive attitudes toward cancer screening. Regression analysis revealed that approximately 12% of the variance in cancer screening attitudes could be explained by health perception, highlighting it as a notable determinant of screening behavior. Recent studies support these findings. For example, a systematic review conducted in Ethiopia by Yirsaw et al. (2024) demonstrated that women with higher perceived risk, based on the Health Belief Model, were approximately 3.8 times more likely to participate in cervical cancer screening²¹. This indicates that individuals' health perception serves as a strong determinant of screening behaviors. Similarly, a study conducted in the United States by Asare et al. (2024) demonstrated that knowledge, awareness, and health perception play a significant role in participation in cervical cancer screening¹¹. These findings are consistent with the results of our study and indicate that health perception plays a key role not only at the particular level but also at the societal level in promoting screening behaviors. Recent evidence further suggests that interventions targeting perceived susceptibility and perceived benefits significantly improve screening uptake, reinforcing the central role of health perception in preventive health behaviors. Another noteworthy finding of our research was that individuals who had knowledge about cancer demonstrated significantly higher health perception scores. This suggests that knowledge enhances health perception and positively contributes to screening behaviors, a result that is also supported by the existing literature. Asare et al. (2024) emphasized that knowledge and awareness are fundamental determinants of participation in cervical cancer screening and highlighted that health literacy is a critical factor influencing screening uptake¹¹. Therefore, it can be suggested that programs aimed at improving health literacy may also enhance individuals' health perception and encourage participation in screening programs. In line with recent public health approaches, improving health literacy has been identified as a key strategy to reduce disparities in cancer screening participation.

It was noteworthy that a significant proportion of participants (60.1%) had never undergone any cancer screening. Benavidez et al. (2021) reported that only half of

women in the United States met the screening criteria recommended by the USPSTF⁷. This indicates that low participation in cancer screening is not unique to Turkey, but is a global concern. The low screening rates observed in our study may be attributed to factors such as lack of knowledge, insufficient awareness, barriers to accessing healthcare services, and time management challenges. In a systematic review, Yirsaw et al. (2022) highlighted that fear, anxiety, embarrassment, and concern about diagnosis are among the factors negatively affecting screening participation, suggesting that engagement in screening is influenced not only by cognitive but also by emotional processes²¹. Recent studies also emphasize structural barriers such as accessibility of services and appointment systems as critical determinants of screening participation^{25,26}.

In our study, no significant relationship was found between socio-demographic variables and screening attitudes. This finding suggests that attitudes toward cancer screening are influenced not only by demographic factors such as age, gender, or education, but more substantially by health perception, knowledge levels, and psychosocial factors. Similarly, a review by Calderon et al. (2022) demonstrated that key determinants shaping screening behaviors include health perception, health beliefs, social support, and emotional barriers²⁷. This finding indicates that health policies should not focus solely on specific demographic groups, but rather develop comprehensive strategies aimed at enhancing health perception across the entire population and reducing psychosocial barriers.

In our study, the most frequently consulted source of information by participants was healthcare professionals (37.9%). This finding highlights the critical role of healthcare workers in disseminating information and raising awareness within the community. Similarly, the literature indicates that guidance and education provided by healthcare professionals positively influence individuals' screening behaviors. Deatrack et al. (2022) emphasized that systematic risk assessments offered by healthcare providers to families not only enhance knowledge levels but also strengthen participation in screening programs¹⁴. Accordingly, providing continuous in-service training on cancer screening for healthcare professionals working in family health centers would facilitate individuals' access to reliable information and is expected to increase participation rates. Moreover, patient-provider communication has been identified as one of the most influential factors in improving adherence to preventive screening recommendations.

Among the strengths of this study is the simultaneous assessment of health perception and attitudes toward cancer screening within the same sample. This approach provides a comprehensive perspective on the relationship between health perception and screening behaviors. Additionally, the inclusion of participants from diverse socio-demographic backgrounds enhances the variability of the results, thereby increasing the study's value.

Limitations

The limitations of the study should also be considered. First, the cross-sectional design of the study does not allow for establishing a causal relationship between health

perception and screening attitudes. Additionally, conducting the research with only individuals attending a single family center in Muğla limits the generalizability of the findings to the broader population of Turkey. The self-reported nature of the data collection may also introduce risks of recall bias and social desirability bias.

Conclusion

In conclusion, this study demonstrates that health perception has a significant effect on attitudes toward cancer screening. The findings suggest that interventions aimed at strengthening health perception, increasing individuals' knowledge, and reducing psychosocial barriers could enhance participation in cancer screening. Therefore, comprehensive educational programs, community awareness campaigns, and psychosocial support interventions implemented at family health centers may play a critical role in improving the effectiveness of cancer screening programs. Future research using larger samples and longitudinal designs across different regions will provide a more detailed understanding of changes in health perception over time and their effects on screening behaviors.

REFERENCES

1. Grassi L, Caruso R, Sabato S, Massarenti S, Nanni MG. Psychosocial screening and assessment in oncology and palliative care settings. *Front Psychol.* 2015;7(5):1485. doi:10.3389/fpsyg.2014.01485.
2. Duffy SW, Vulkan D, Cuckle H, et al. Effect of mammographic screening from age 40 years on breast cancer mortality (UK Age trial): Final results of a randomised, controlled trial. *Lancet Oncol.* 2020;21(9):1165–72. doi:10.1016/S1470-2045(20)30398-3.
3. Draeger DL, Sievert KD, Hakenberg OW. Psychosocial distress in bladder cancer stratified by gender, age, treatment, and tumour stage. *Urol Int.* 2018;101(1):31–7. doi:10.1159/000489502.
4. Goulart BHL, Bensink ME, Mummy DG, Ramsey SD. Lung cancer screening with low-dose computed tomography: Costs, national expenditures, and cost-effectiveness. *Journal of the National Comprehensive Cancer Network.* 2012;10(2):267–75. doi:10.6004/jnccn.2012.0023.
5. Douma LN, Uiters E, Timmermans DRM. Why are the public so positive about colorectal cancer screening? *BMC Public Health.* 2018 Dec 30;18(1):1212. doi:10.1186/s12889-018-6106-1.
6. Long KA, Pariseau EM, Muriel AC, et al. Psychosocial screening for siblings of children with cancer: Barriers and preferences. *Clin Pract Pediatr Psychol.* 2017;5(4):364–75. doi:10.1037/cpp0000219.

7. Benavidez GA, Zgodic A, Zahnd WE, Eberth JM. Disparities in meeting USPSTF breast, cervical, and colorectal cancer screening guidelines among women in the United States. *Prev Chronic Dis*. 2021;15(18):200315. doi:10.5888/pcd18.200315.
8. Bogaarts MPJ, Den Oudsten BL, Roukema JA, Van Riel JMGH, Beerepoot L V, De Vries J. Development of the psychosocial distress questionnaire—breast cancer (pdq-bc): A breast cancer-specific screening instrument for psychosocial problems. *Supportive Care in Cancer*. 2011;19(10):1485–93. doi:10.1007/s00520-010-0968-9.
9. Kendall J, Glaze K, Oakland S, Hansen J, Parry C. What do 1281 distress screeners tell us about cancer patients in a community cancer center? *Psychooncology*. 2011;20(6):594–600. doi:10.1002/pon.1907.
10. Le D, Hong A, Azor Hui SK, Rimal RN, Juon HS. Assessment of hepatitis b virus screening behaviors among asian-americans through the lens of social cognitive theory. *Calif J Health Promot*. 2021;19(1):76–83. doi:10.32398/cjhp.v19i1.2652.
11. Asare M, Owusu-Sekyere E, Elizondo A, Benavidez GA. Exploring cervical cancer screening uptake among women in the United States: Impact of social determinants of health and psychosocial determinants. *Behav Sci (Basel)*. 2024;14(9):811. doi:10.20944/preprints202408.0584.v1.
12. Kazak AE, Brier M, Alderfer MA, et al. Screening for psychosocial risk in pediatric cancer. *Pediatr Blood Cancer*. 2012 Nov 10;59(5):822–7. doi:10.1002/pbc.24166.
13. Bonney A, Brodersen J, Siersma V, et al. Validation of the psychosocial consequences of screening in lung cancer questionnaire in the international lung screen trial Australian cohort. *Health Qual Life Outcomes*. 2024 Jan 25;22(1):10. doi:10.1186/s12955-023-02225-8.
14. Deatrick JA, Kazak AE, Scialla MA, et al. Advancing health equity in pediatric cancer through implementation of universal family psychosocial risk screening. *Psychooncology*. 2022;31(9):1483–90. doi:10.1002/pon.5978.
15. Sidabutar S, Martini S, Wahyuni CU. Analysis of factors affecting women of childbearing age to screen using visual inspection with acetic acid. *Osong Public Health Res Perspect*. 2017;8(1):61–4. doi:10.24171/j.phrp.2017.8.1.08.
16. Scialla MA, Canter KS, Chen FF, et al. Implementing the psychosocial standards in pediatric cancer: Current staffing and services available. *Pediatr Blood Cancer*. 2017;64(11). doi:10.1002/pbc.26634.
17. Lazenby M, Tan H, Pasacreta N, Ercolano E, McCorkle R. The five steps of comprehensive psychosocial distress screening. *Curr Oncol Rep*. 2015;17(5):22. doi:10.1007/s11912-015-0447-z.
18. Yang YL, Liu L, Li MY, Shi M, Wang L. Psychological disorders and psychosocial resources of patients with newly diagnosed bladder and kidney cancer: A cross-sectional study. *PLoS One*. 2016;11(5):e0155607. doi:10.1371/journal.pone.0155607.

19. Looijmans M, van Manen AS, Traa MJ, Kloover JS, Kessels BLJ, de Vries J. Psychosocial consequences of diagnosis and treatment of lung cancer and evaluation of the need for a lung cancer specific instrument using focus group methodology. *Supportive Care in Cancer*. 2018;26(12):4177–85. doi:10.1007/s00520-018-4291-1.
20. Cruz-Castillo AB, Hernández-Valero MA, Hovick SR, Campuzano-González ME, Karam-Calderón MA, Bustamante-Montes LP. A study on the knowledge, perception, and use of breast cancer screening methods and quality of care among women from central Mexico. *Journal of Cancer Education*. 2015;30(3):453–9. doi:10.1007/s13187-014-0722-y.
21. Yirsaw AN, Tefera M, Bogale EK, Anagaw TF, Tiruneh MG, Fenta ET, et al. Applying the Health Belief Model to cervical cancer screening uptake among women in Ethiopia: A systematic review and meta-analysis. *BMC Cancer*. 2024;24(1):1294. doi:10.1186/s12885-024-13055-2.
22. Yıldırım Öztürk EN, Uyar M, Şahin TK. Development of an Attitude Scale for Cancer Screening. *Turkish Journal of Oncology*. 2020;4(35):394–404. doi:10.5505/tjo.2020.2341.
23. Diamond JJ, Becker JA, Arenson CA, Chambers C V., Rosenthal MP. Development of a scale to measure adults' perceptions of health: Preliminary findings. *J Community Psychol*. 2007;35(5):557–61. doi:10.1002/jcop.20164.
24. Kadioğlu H, Yıldız A. Validity and reliability of Turkish version of Perception of Health Scale. *Turkiye Klinikleri Journal of Medical Sciences*. 2012;32(1):47–53. doi:10.5336/medsci.2010-21761.
25. Hutton G, Li SJ, Quaife SL, Brentnall A, Cookson J, Jenkins J, et al. Understanding barriers to breast screening: An online survey of non-attenders as part of a service evaluation in the breast screening programme in England. *BMC Public Health*. 2025;25(1):2509. doi:10.1186/s12889-025-23691-3.
26. Sung B, O'Driscoll F, Gregory A, Grailey K, Franklin H, Poon S, et al. Identifying barriers to outpatient appointment attendance in patient groups at risk of inequity: A mixed methods study in a London NHS trust. *BMC Health Serv Res*. 2024;24(1):554. doi:10.1186/s12913-024-10947-8.
27. Calderon C, Lorenzo-Seva U, Ferrando PJ, Sorribes E, Rodríguez-González A, Obispo BM, et al. Measurement properties of the Spanish version of the brief resilient coping scale (BRCS) in cancer patients. *International Journal of Clinical and Health Psychology*. 2022;22(3):100313. doi:10.1016/j.ijchp.2022.100313.

The Mediating Role of Self-Esteem in the Effect of Muscle Dysmorphia on Exercise Dependence

Aydan AKKURT YALÇINTÜRK*, Ahmet Kamil YILMAZ**, İrem İclal KARADAŞ***

Abstract

Aim: The aim of this study was to determine the mediating role of self-esteem in the effect of muscle dysmorphia on exercise dependence in young men.

Method: This descriptive study was conducted with 500 male individuals aged 18-30 years living in Turkey. Data were collected using the "Descriptive Information Form", the "Muscle Dysmorphia Disorder Inventory", the "Exercise Dependence Scale" and the "Rosenberg Scale of Self-esteem".

Results: The effect of muscle dysmorphia on exercise dependence was found to be significant and positive. The effect of self-esteem level on exercise dependence was found to be significant and negative. It was determined that the effect of "Muscle Dysmorphia Inventory" on "Exercise Dependence Scale" was realized through the variable "Rosenberg Scale of Self-esteem" ($B=-0.08$, $\beta=-0.03$, $SH=0.02$, $LLCI=-0.13$, $ULCI=-0.04$). This finding shows that each unit increase in the "Muscle Dysmorphia Disorder Inventory" score causes a 0.08 unit decrease in the "Exercise Dependence Scale" score through the "Rosenberg Scale of Self-esteem", in other words, there is a mediation effect.

Conclusion: In this study, it was determined that high levels of muscle dysmorphia increased the risk of exercise dependence in young men, but self-esteem had a decreasing role on this negative effect.

Keywords: Self-esteem, exercise dependence, muscle dysmorphia.

Kas Dismorfisinin Egzersiz Bağımlılığına Etkisinde Benlik Saygısının Aracı Rolü

Öz

Amaç: Bu çalışmanın amacı; genç erkeklerde kas dismorfisinin egzersiz bağımlılığına etkisinde benlik saygısının aracılık rolünün belirlenmesidir.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 19.03.2025 **Kabul / Accepted:** 29.07.2026

DOI: <https://doi.org/10.38079/igusabder.1661067>

* Asst. Prof., Department of Psychiatric Nursing, Hamidiye Faculty of Nursing, University of Health Sciences, Istanbul, Türkiye. E-mail: aydan.akkurtyalcinturk@sbu.edu.tr [ORCID https://orcid.org/0000-0002-5386-0624](https://orcid.org/0000-0002-5386-0624)

** Nursing Student, Department of Nursing, Faculty of Health Sciences, Üsküdar University, Istanbul, Türkiye.

E-mail: ahmetkamil.yilmaz@st.uskudar.edu.tr [ORCID https://orcid.org/0009-0004-0566-0216](https://orcid.org/0009-0004-0566-0216)

*** Nursing Student, Department of Nursing, Faculty of Health Sciences, Üsküdar University, Istanbul, Türkiye.

E-mail: iremiclal.karadas@st.uskudar.edu.tr [ORCID https://orcid.org/0009-0006-1185-7829](https://orcid.org/0009-0006-1185-7829)

ETHICAL STATEMENT: Ethics committee approval for the study was received from the Üsküdar University Ethics Committee (2024-61351342/020-132).

Yöntem: Tanımlayıcı nitelikteki bu çalışma, Türkiye’de yaşayan 18-30 yaş arasındaki 500 erkek birey ile gerçekleştirilmiştir. Veriler “Tanımlayıcı Bilgi Formu”, “Kas Algısı Bozukluğu Envanteri”, “Egzersiz Bağımlılığı Ölçeği” ve “Rosenberg Benlik Saygısı Ölçeği” ile toplanmıştır.

Bulgular: Kas dismorfisinin egzersiz bağımlılığı üzerindeki etkisinin anlamlı ve pozitif yönde olduğu belirlenmiştir. Benlik saygısı düzeyinin egzersiz bağımlılığı üzerindeki etkisinin ise anlamlı ve negatif yönde olduğu saptanmıştır. “Kas Algısı Bozukluğu Envanteri”nin “Egzersiz Bağımlılığı Ölçeği” üzerindeki etkisinin “Rosenberg Benlik Saygısı Ölçeği” değişkeni aracılığıyla gerçekleştiği belirlenmiştir ($B=-0,08$, $\beta=-0,03$, $SH=0,02$, $LLCI=-0,13$, $ULCI=-0,04$). Bu bulgu, “Kas Algısı Bozukluğu Envanteri” puanındaki her bir birimlik artışın, “Rosenberg Benlik Saygısı Ölçeği” aracılığıyla “Egzersiz Bağımlılığı Ölçeği” puanında 0,08 birimlik bir azalmaya neden olduğu diğer bir ifade ile aracılık etkisinin olduğunu göstermektedir.

Sonuç: Bu çalışmada, genç erkeklerde kas dismorfisi düzeyinin yüksek olmasının egzersiz bağımlılığı görülme riskini artırdığı fakat bu negatif etki üzerinde benlik saygısının azaltıcı rolünün olduğu belirlenmiştir.

Anahtar Sözcükler: Benlik saygısı, egzersiz bağımlılığı, kas dismorfisi.

Introduction

Body image is a multidimensional structure that includes cognitive, emotional and behavioral elements, in other words, an individual's perceptions, feelings, thoughts and behaviors about their own body^{1,2}. Body image can be positive or negative. Self-dissatisfaction, which is one of the indicators of negative body image, is frequently seen in men. Men may experience psychological problems due to dissatisfaction with their bodies. One of these problems is muscle dysmorphia. Muscle dysmorphia is a condition in which a person has an unrealistic perception of their own muscles. These individuals may experience a constant feeling of dissatisfaction with their muscles and tend to perceive their muscles as smaller or inadequate^{3,4}. This perception can negatively affect one's self-esteem. Individuals may face problems such as low self-esteem, self-dislike, social inhibition, and even depression. Therefore, there is a positive relationship between a positive body perception and healthy self-esteem^{5,6}. Although the prevalence of muscle dysmorphia in the general population is not yet known, it is accepted that it is much more common in men than in women^{3,4}. In a study conducted with Australian individuals, the prevalence of muscle dysmorphia was found to be 2.2% among men⁷.

Men can try various methods to cope with dissatisfaction with their bodies. Among these, exercise is the most common method. Exercising to achieve the desired body shape can turn into exercise dependence over time. Exercise dependence is a state of excessive exercise in which moderate to intense physical activity turns into a compulsive behavior, i.e. engaging in exercise routines, excessive exercise and inability to control exercise behavior. The individual is driven to exercise for longer and more regular periods of time, to the detriment of their personal, social and professional life, even ignoring clinical advice or treatment, regardless of the detrimental health consequences. They exercise even when exhausted, injured or ill. When the individual abstains from exercise, they show withdrawal symptoms characterized by behavioral dependences^{8,9}. In a study

conducted with elite athletes and sports science faculty students, it was determined that male athletes had high levels of exercise dependence¹⁰.

Exercise dependence is a disorder characterized by excessive and obsessive exercise patterns that ultimately lead to physical and psychological distress. Dissatisfaction with one's current appearance plays an important role in the formation of exercise dependence¹¹. Low self-esteem is among the triggering effects of exercise dependence¹². In the study conducted by Wågan et al. (2021), it was determined that individuals who exercise more than 9 hours a week have lower self-esteem levels¹³.

In the literature, it is stated that the incidence of muscle dysmorphia and exercise dependence in young men is high, but there is no study addressing the mediating role of self-esteem, which may be a trigger in muscle dysmorphia and exercise dependence^{4,10}. In this respect, it is thought that the study will contribute to the literature. In addition, the study will contribute to the development of knowledge about muscle dysmorphia and exercise dependence, which can lead to many negative consequences in young men, to investigate the variables associated with them, and to develop interventions to increase self-esteem. For this reason, this study was conducted to investigate the mediating role of self-esteem in the effect of muscle dysmorphia on exercise dependence in young men.

Material and Methods

Type of Research

This study used a descriptive research design.

Time of the Research

The research was conducted between June and September 2024.

Population and Sample of the Study

The population of the study consisted of men between the ages of 18-30 living in Turkey. According to TurkStat data, the male population between the ages of 18 and 30 in Turkey is approximately 6 million 673 thousand 163 people¹⁴. While determining the sample, the sample size calculation table developed by Yazicioğlu and Erdoğan (2004) was utilized. Accordingly, at least 384 participants with a sampling error of 0.05 ($p=0.05$ and $q=0.5$) were considered sufficient for the sample¹⁵. Snowball sampling method was used to create the sample group. Data collection forms were distributed online by researchers through social media platforms and email groups. The sample of the study consisted of 500 young male individuals.

Hypotheses of the Study

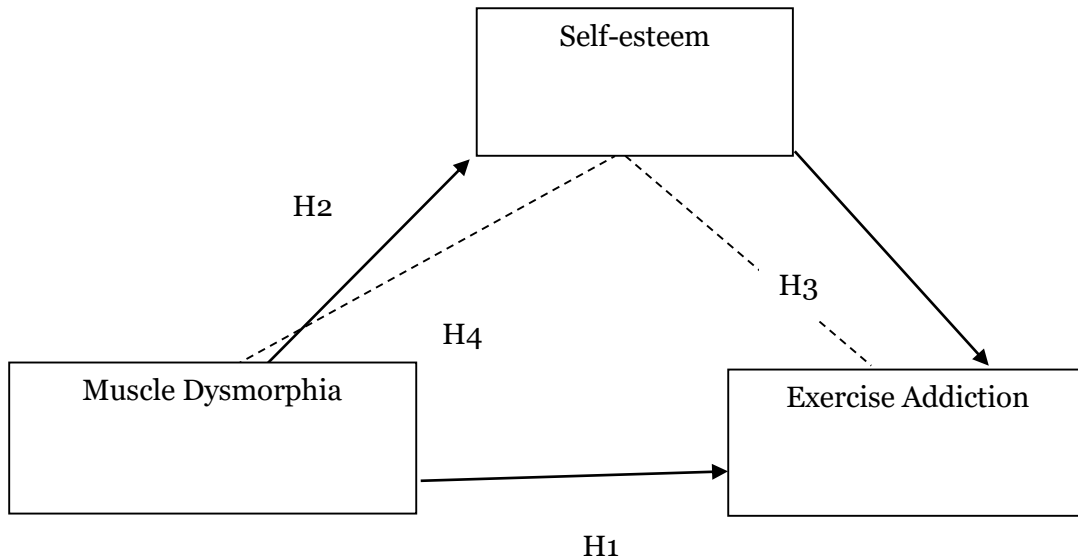
H1: Muscle dysmorphia positively and significantly affects exercise dependence in young men.

H2: Muscle dysmorphia negatively and significantly affects self-esteem in young men.

H3: Self-esteem negatively and significantly affects exercise dependence in young men.

H4: Self-esteem mediates the effect of muscle dysmorphia on exercise dependence in young men (Figure 1).

Figure 1. Hypotheses of the study



Variables of the Study

Independent variable: descriptive characteristics and mean score of "Muscle Dysmorphia Disorder Inventory"

Dependent variable: mean score of "Exercise Dependence Scale"

Mediator variable: mean score of "Rosenberg Scale of Self-esteem"

Data Collection Tools

The data were collected with "Descriptive Information Form", "Muscle Dysmorphia Disorder Inventory", "Exercise Dependence Scale" and "Rosenberg Scale of Self-esteem".

Descriptive Information Form: This form, which was created by the researchers by reviewing the relevant literature, includes a total of 7 questions about the age, height, weight, educational status, marital status, and training status of the individuals^{10,16,17}.

Muscle Dysmorphia Disorder Inventory (MDDI): It was developed to measure the diagnostic criteria of muscle perception disorder^{18,19}. MDDI is a 13-item, five-point Likert-type scale. The scale includes the statements "never (1), sometimes (2), undecided

(3), mostly (4) and always (5)". The score that can be obtained from the scale varies between 13-65 points. The Cronbach's Alpha of the scale was found to be .81¹⁹. Cronbach's alpha for this study is .84.

Exercise Dependence Scale (EDS-21): The scale is applicable to individuals aged 18 years and over. It consists of 21 items. The exercise dependence symptoms of the participants are evaluated on a 6-point Likert-type scale. A high score indicates that the person has more exercise dependence symptoms^{20,21}. The Cronbach's Alpha of the scale in the original study was 0.90²¹. Cronbach's alpha for this study is .96.

Rosenberg Scale of Self-esteem: It was developed to determine general self-esteem through self-report²². There are 63 items in the scale consisting of 12 multiple-choice subscales. Self-esteem subscale was used in this study. The self-esteem subscale has a four-point Likert-type structure consisting of 10 items. Scores obtained from the scale are evaluated as 0-1 point high level, 2-4 points medium level and 5-6 points low self-esteem level. The Cronbach's Alpha of the scale in the original study was 0.71²³. Cronbach's alpha for this study is .79.

Data Collection

Ethics committee approval for the study was received from the Üsküdar University Ethics Committee (2024-61351342/020-132).

In the data collection phase, an online questionnaire was created through Google Forms, in which forms and scales will be used. The questionnaire was delivered to the participants within the scope of the study. The survey link reached people through social media platforms and e-mail groups. The characteristics of the participants included in the survey were that they were male between the ages of 18-30 and wanted to participate in the study completely voluntarily. For this reason, the Informed Consent Form was displayed on the screen at the entrance to the survey for the participants with these characteristics, and the individuals who wanted to participate in the research by selecting the approval option, while the individuals who did not want to participate were able to close their screens. The questionnaires were completed in approximately 30 minutes.

Data Analysis

All data were saved and analyzed on the computer using the SPSS 22 program. Mediation analysis was performed using IBM SPSS Process Macro 4.1 application. The normality of the data distribution was assessed using the Kolmogorov–Smirnov test, skewness and kurtosis values, and histogram plots. The Kolmogorov–Smirnov test results indicated that the data were normally distributed ($p > .05$). Skewness and kurtosis values ranged between -1.5 and $+1.5$, further supporting normality. Analyses were performed with parametric tests.

Results

When the descriptive characteristics of the individuals who participated in the study were examined, it was determined that the mean age of the individuals was 24.11 ± 4.00 , 77% were undergraduate graduates, 78.20% were single, and the mean BMI was 25.59 ± 3.49 . It was found that 47.20% of the individuals practiced bodybuilding training, and the average training time of the individuals who trained regularly was 1.88 ± 1.98 hours per day (Table 1).

Table 1. Descriptive characteristics of the participants (n=500)

		n	%
Educational status	Literate	5	1
	Primary education	15	3
	High school	78	15.60
	University	385	77.00
	Postgraduate	17	3.40
Marital status	Married	109	21.80
	Single	391	78.20
Status des Bodybuilding-Trainings/ Sports	Yes	236	47.20
	No	264	52.80
YAge	Mean$\pm$SD	24.11 $\pm$ 4.00	
BMI	Mean$\pm$SD	25.59 $\pm$ 3.49	
Hours Of Daily Exercise	Mean$\pm$SD	1.88 $\pm$ 1.98	

BMI: Body Mass Index; n: number of participants; SD: Standard Deviation

The mean score of the "Muscle Dysmorphia Disorder Inventory" was 28.37 ± 8.03 , "Exercise Dependence Scale" was 49.22 ± 19.77 , and "Rosenberg Scale of Self-esteem" was 20.26 ± 4.98 (Table 2).

Table 2. "Muscle Dysmorphia Disorder Inventory", "Exercise Dependence Scale" and "Rosenberg Scale of Self-esteem" results related to the mean scores (N=500)

	Minimum	Maximum	Mean	SD
Muscle Dysmorphia Disorder Inventory	13	48	28.37	8.03
Exercise Dependence Scale	21	114	49.22	19.77
Rosenberg Scale of Self-esteem	10	31	20.26	4.98

SD: Standard Deviation

The total effect of the "Muscle Dysmorphia Disorder Inventory" on the "Exercise Dependence Scale" was statistically significant ($B=1.08$, $\beta=0.44$, $LLCI=0.89$, $ULCI=1.28$). This finding shows that each one-unit increase in the "Muscle Dysmorphia

Disorder Inventory" score causes a 1.08-unit increase in the "Exercise Dependence Scale" score. When the direct effect was analyzed, it was found that the direct effect of the "Muscle Dysmorphia Disorder Inventory" on the "Exercise Dependence Scale" score was statistically significant ($B=1.17$). This finding shows that each one-unit increase in the "Muscle Dysmorphia Disorder Inventory" score causes a 1.17-unit increase in the "Exercise Dependence Scale" score.

When the indirect effect was analyzed, it was determined that the effect of "Muscle Dysmorphia Disorder Inventory" on "Exercise Dependence Scale" was realized through the variable "Rosenberg Scale of Self-esteem" ($B=-0.08$). This finding shows that each unit increase in the "Muscle Dysmorphia Disorder Inventory" score causes a 0.08 unit decrease in the "Exercise Dependence Scale" score through the the "Rosenberg Scale of Self-esteem", in other words, there is a mediation effect.

The effect of the "Muscle Dysmorphia Disorder Inventory" on the "Rosenberg Scale of Self-esteem" was found to be negative and statistically significant ($B=-0.12$). In addition, the effect of the "Rosenberg Scale of Self-esteem" on the "Exercise Dependence Scale" was negative and statistically significant ($B=-0.69$). This finding shows that each unit increase in the "Rosenberg Self-Esteem Scale" score causes a 0.69 unit decrease in the "Exercise Dependence Scale" score.

When the explanatory power of the model was evaluated, $R^2=0.04$ explaining the effect of the "Muscle Dysmorphia Disorder Inventory" on the "Rosenberg Scale of Self-esteem" and the model was found to be significant ($F(1,498)=19.89$, $p<0.001$). The explanatory model of the Exercise Dependence Scale was $R^2=0.22$ and the model was found to be significant $F(2,497)=70.91$, $p<0.01$. These findings reveal that the effect of muscle dysmorphia on exercise dependence is realized both directly and indirectly through self-esteem and self-esteem plays a mediating role in this relationship (Table 3, Figure 2).

Table 3. Results on the mediating role of self-esteem in the effect of muscle dysmorphia disorder on exercise addiction (N=500)

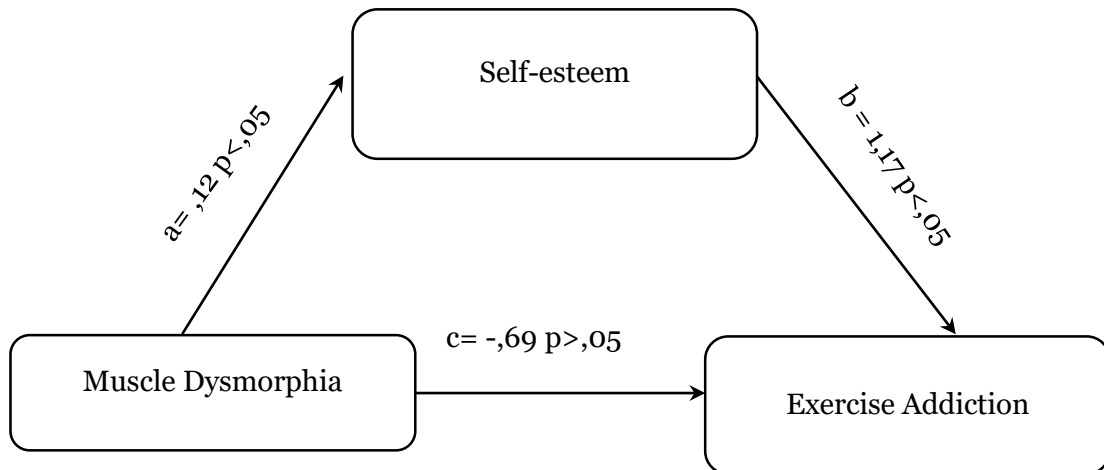
	Rosenberg Scale of Self-esteem					Exercise Dependence Scale				
	B	β	SE	LLCI	ULCI	B	β	SE	LLCI	ULCI
Muscle Dysmorphia Disorder Inventory	-0.12	0.20	0.03	0.07	0.18	1.17	0.47	0.10	0.97	1.36
Rosenberg Scale of Self-esteem	---					-0.69	-0.17	0.16	-1.01	-0.38
Fixed	16.81		0.8			30.24		3.94		
	$R^2=,04$					$R^2=,22$				
	$F(1.498)=19.89$; $p<.001$					$F(2.497)=70.91$; $p<0.01$				

Total Effect	1.08	0.44	0.10	0.89	1.28
Direct Effect	1.17	0.47	0.10	0.97	1.36
Indirect Effect	-0.08	-0.03	0.02	-0.13	-0.04

B: Unstandardized Regression Coefficient; β : Standardized Regression Coefficient.

SE: Standard Error; LLCI: Lower Confidence Interval (B); ULCI: Upper Confidence Interval (B) * $p < 0.05$

Figure 2. Findings of the analysis series in which self-esteem was evaluated as a mediating variable



Direct effect (c) = 1.17 $p < 0.05$

Indirect effect ($a*b$) = -0.08 $p < 0.05$

Discussion

In the study, it was determined that almost half of the young men practiced bodybuilding training. Bodybuilding training/ exercise/ sport is mostly preferred by male individuals worldwide because it expresses the ideal body structure for male individuals both socially and culturally²⁴. This type of sport is known as a sport that challenges the individual both physically and mentally. In this type of sport, in which the individual makes an important investment in their body, the perceptions of the individual towards their body may also change over time²⁵. In a study involving adult individuals who exercise in sports centers in Ankara, it was stated that as individuals place exercise at the center of their lives, they may evaluate themselves as physically inadequate in terms of body image and muscle mass²⁶. Since bodybuilding has a lifestyle that requires serious discipline, some

psychiatric disorders are observed in individuals interested in this sport over time²⁷. Muscle dysmorphia is a psychiatric disorder that generally affects individuals who engage in bodybuilding sports and causes individuals to feel obsessed by seeing themselves inadequate in terms of muscle mass²⁸.

Both men and women experience symptoms of muscle dysmorphia, but research reveals that men generally report much higher levels of symptomatology than women^{29,30}. Muscle dysmorphia affects men and young people more than women^{31,32}. Arslan et al. (2022) found that muscle dysmorphia symptoms and bodybuilding dependence are often associated with male students³³. The International Obsessive Compulsive Disorder Foundation states that 0.5% of men may meet the criteria for muscle dysmorphia³⁴. Duran et al. (2020) and Merhy et al. (2023) reported high levels of muscle dysmorphia symptoms in male university students^{35,36}. Skemp et al. (2013) also reported that male individuals had a higher risk of muscle dysmorphia than females in their study with bodybuilders³⁷.

In the study, it was determined that the mean score of "Muscle Dysmorphia Disorder Inventory" was 28.37 ± 8.03 in young men. In the study conducted by Sentürk and Göbel (2024) in male athletes, the muscle dysmorphia scale was 27.5 ± 9.09 and the rate of athletes with muscle dysmorphia was 10.1%. At the same time, it was found that exercise dependence increased as the athletes' scores on the muscle dysmorphia scale increased³⁸. In a study conducted with male university students, it was determined that there was a relationship between muscle dysmorphia and bodybuilding dependence³³. Latorre Román et al. (2016) found a significant association between body dissatisfaction, a key aspect of muscular dysmorphia, and exercise dependence. It seems logical that a person who develops their muscles through physical exercise would develop exercise addiction along with muscular dysformity³⁹. Similarly, a positive correlation was found between muscle dysmorphia and exercise dependence in this study.

Because individuals are dissatisfied with their current body shape, they try to achieve an ideal body image, such as being more muscular by exercising more, so this goal can trigger muscle dysmorphia. It is seen that muscle dysmorphia and body image disturbance have a bidirectional interaction, muscle dysmorphia can be triggered when the person is dissatisfied with their current body shape, and as muscle dysmorphia develops, body image perception may deteriorate further⁴⁰. In the study conducted by Selvi and Bozo (2020), it was found that muscularity desire and body dissatisfaction were positively associated with muscle dysmorphia⁴¹. In the study conducted by Greenway and Price (2020), it was stated that muscle dysmorphia is associated with the individual being ashamed of their own body and feeling small and weak⁴². In another study by Murray et al. (2012), individuals with muscle dysmorphia had poor body perception and did not like their bodies⁴³. In the study conducted by Sentürk and Göbel (2024), it was found that body perception disorders increased as the risk of muscle dysmorphia increased in athletes³⁸. In their study, Compte et al. (2015) stated that individuals at risk of muscle dysmorphia were prone to low self-esteem⁴⁴. Increased levels of muscle dysmorphia lead to increased negative self-evaluations of body image, which is

associated with decreased self-esteem⁴⁵. Similarly, in this study was a negative relationship between muscle dysmorphia and self-esteem, self-esteem decreased as muscle dysmorphia increased, and the risk of muscle dysmorphia increased when self-esteem decreased.

The remarkable finding of this study is that the mediation analysis revealed that self-esteem a moderating role in the negative effect of muscle dysmorphia on exercise dependence in young men. In other words, muscle dysmorphia shows some of its effect on exercise dependence through self-esteem. High self-esteem has a reducing effect on the risk of exercise dependence. Ertl et al. (2018) found that self-esteem positively predicted exercise dependence⁴⁶. In the study conducted by Wågan et al. (2021), self-esteem and exercise dependence were significantly related to each other¹³. Therefore, it is thought that individuals with high self-esteem do not try to exercise more to increase their satisfaction with themselves. In this direction, it is thought that the risk of exercise dependence in individuals will decrease with programs aimed at increasing self-esteem.

Conclusion and Recommendations

In conclusion, this study determined that high levels of muscle dysmorphia increase the risk of exercise addiction in young men, and self-esteem plays a moderating role in this relationship. High self-esteem has a mitigating effect on the risk of exercise addiction. In line with this result, young men should be considered a risk group, and early screening programs should be developed for them. It is recommended that psycho-educational programs and group studies aiming to reduce muscle dysmorphia and increase self-esteem should be applied to young men. Individuals should receive training on healthy body image, realistic physical expectations, and the psychological effects of muscular dysmorphia. Awareness-raising programs should be developed, particularly for young men, regarding the effects of social media. Psychosocial programs should be designed to focus on individuals' strengths. Individuals should be encouraged to participate in activities that enhance their sense of achievement and competence. This will prevent self-esteem from being judged solely on physical appearance.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Grogan S. *Body Image: Understanding Body Dissatisfaction in Men, Women and Children*. 3rd ed. Routledge, 2017.

2. Thompson JK, Burke NL, Krawczyk R. Measurement of body image in adolescence and adulthood. In: Cash TF, ed. *Encyclopedia of Body Image and Human Appearance*, 2012.
3. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. 2013.
4. Selvi K. I am not muscular enough, I should develop my muscles more: A detailed look at muscle dysmorphia. *Journal of Clinical Psychology*. 2023;7(2):271-290.
5. Bo S, Zoccali R, Ponzo V, et al. University courses, eating problems and muscle dysmorphia: Are there any associations? *Journal of Translational Medicine*. 2014;12(1):221. doi: 10.1186/s12967-014-0221-2.
6. Oktan V, Şahin M. Examination of the relationship between the body image and self-esteem of female adolescents. *Journal of Human Sciences*. 2010;7(2):543-546.
7. Mitchison D, Mond J, Griffiths S, et al. Prevalence of muscle dysmorphia in adolescents: findings from the *EveryBODY* study. *Psychol Med*. 2022;52(14):3142-3149.
8. Adams JM. Understanding exercise dependence. *J Contemp Psychother*. 2009;39:231-240.
9. De Coverley Veale DMW. Exercise dependence. *British Journal of Addiction*. 1987;82(7):735-740.
10. Cicioğlu Hİ, Tekkurşun Demir G, Bulğay C, Çetin E. Exercise addiction levels among elite level athletes and students of sports sciences faculty. *Journal of Dependence*. 2019;20(1):12-20.
11. Arslanoğlu C, Acar K, Mor A, et al. Investigating the quality of life of university students in terms of exercise status. *The Erzincan University Journal of Education Faculty*. 2021;23(1):187-198. doi: 10.17556/erziefd.745549.
12. Devrim A. The Validity and Reliability Study of Themuscle Dysmorphic Disorder Inventory and Bodybuilder Image Grid and The Evaluation of Their Relations to Eating Attitude Test [master's thesis]. Ankara, Turkey: Hacettepe University Health Sciences Institute;2016.
13. Wågan FA, Darvik MD, Pedersen AV. Associations between self-esteem, psychological stress, and the risk of exercise dependence. *Int J Environ Res Public Health*. 2021;18(11):5577. doi: 10.3390/ijerph18115577.
14. TurkStat. Address Based Population Registration System Results, 2024, <https://data.tuik.gov.tr/Bulten/Index?p=Adrese-Dayali-Nufus-Kayit-Sistemi->

[Sonuclari-2024-53783](#) Published February 06, 2025. Accessed February 10, 2025.

15. Yazıcıoğlu Y, Erdoğan S. *Spss Applied Scientific Research Methods*. Ankara: Detay Publishing, 2004.
16. Aylıgan E, Cicioğlu İ, Kahya S. Investigation of the relationship between muscle dysmorphia and exercise addiction in male bodybuilders: Example of Sivas. *BESSED*. 2023;2(1):87-99
17. Katra H. Exercise addiction and self-esteem in individuals exercising. *Journal of Dependence*. 2021;22(4):370-378. doi: 10.51982/bagimli.897106.
18. Hildebrandt T, Schlundt D, Langenbucher J. Muscularity concerns among men: development of attitudinal and perceptual measures. *Body Image*. 2004;1:169-181.
19. Subaşı B, Okray Z, Çakıcı M. Validity and reliability of Turkish Form of Muscle Dysmorphia Disorder Inventory among elite bodybuilder men. *Anatolian Journal of Psychiatry*. 2018;19(2):47-54.
20. Hausenblas HA, Downs DS. Exercise dependence: A systematic review. *Psychology Sport and Exercise*. 2002;3:89-123.
21. Yeltepe H, İkizler H. Validation and reliability study of Exercise Dependence Scale-21 in Turkish. *Journal of Dependence*. 2007;8(1):29-35.
22. Rosenberg M. Rosenberg Self-Esteem Scale (RSE). Acceptance and commitment therapy. *Measurespackage*, 1965;61:52-63.
23. Cuhadaroglu F. Self-Esteem in Adolescents [specialization thesis]. Ankara, Turkey: Hacettepe University Faculty of Medicine Department of Psychiatry;1986.
24. Gerrig RJ, Zimbardo PG. *Introduction to Psychology, Psychology and Life*. Ankara: Nobel Academic Publishing, 2014.
25. Abraş H, Erdağ D, Buran A. Investigation of the relationship between muscle dysmorphia disorder, orthorexia nervosa, and motivation in male individuals engaged in bodybuilding sports. *Cyprus Turkish Journal of Psychiatry & Psychology*. 2022;4(1):13-22.
26. Kelecek S, Altıntaş A. Passion and dependence in predicting muscle dysmorphia. *Başkent University Faculty of Health Sciences*. 2021;6(2):179-190.

27. Andersen RE, Barlet SJ, Morgan GD, Brownell KD. Weight loss, psychological, and nutritional patterns in competitive male body builders. *International Journal of Eating Disorders*. 1995;18(1):49-57.
28. Ozoğlu F, Hocaoglu Ç. What is bigorexia? Diagnosis and treatment approaches. *Journal of Sports Education*. 2019;3(2):71-78.
29. Griffiths S, Murray SB. Muscle dysmorphia: Clinical presentation and treatment strategies. In: Anderson LK, Murray SB, Kaye WH eds. *Clinical Handbook of Complex and Atypical Eating Disorders*. Oxford University Press; 2018.
30. Lechner TE, Gill EM, Drees MJ, Hamady CM, Ludy MJ. Prevalence of disordered eating and muscle dysmorphia in college students by predominant exercise type. *International Journal of Exercise Science*. 2019;12(4):989-1000.
31. González-Martí I, Bustos JGF, Jordán ORC, Mayville SB. Validation of a Spanish version of the Muscle Appearance Satisfaction Scale: Escala de satisfacción muscular. *Body Image*, 2012;9(4):517-523. doi: 10.1016/j.bodyim.2012.05.002.
32. John FM. The Invisible Man – A Self-help guide for men with eating disorders, compulsive exercise, and bigorexia. *Nursing Standard*. 2008;22(34):30.
33. Arslan M, Yabancı Ayhan N, Sarıyer ET, Çolak H, Çevik E. The effect of bigorexia nervosa on eating attitudes and physical activity: A study on university students. *International Journal of Clinical Practice*. 2002;24:632-5860. doi: 10.1155/2022/6325860.
34. Olivardia R, Pope HG Jr, Hudson JI. Muscle dysmorphia in male weightlifters: a case-control study. *Am J Psychiatry*. 2000;157(8):1291-1296.
35. Duran S, Çiçekoğlu P, Kaya E. Relationship between orthorexia nervosa, muscle dysmorphic disorder (bigorexia), and self-confidence levels in male students. *Perspect Psychiatr Care*. 2020;56(4):878-884. doi: 10.1111/ppc.12505.
36. Merhy G, Moubarak V, Hallit R, Obeid S, Hallit S. The indirect role of orthorexia nervosa and eating attitudes in the association between perfectionism and muscle dysmorphic disorder in Lebanese male University students - results of a pilot study. *BMC Psychiatry*. 2023;23(1):55. doi: 10.1186/s12888-023-04549-7.
37. Skemp KM, Mikat RP, Schenk KP, Kramer NA. Muscle dysmorphia: risk may be influenced by goals of the weightlifter. *Journal of Strength and Conditioning Research*. 2013;2427-2432.
38. Sentürk G, Göbel P. The relationship of muscle dysmorphia with exercise addiction, body image and protein consumption in male power and strength athletes. *Hacettepe University Faculty of Health Sciences Journal*. 2024;11(3):859-871.

39. Latorre Román PÁ, Jiménez Obra A, Párraga Montilla J, García Pinillos F. Dependencia al ejercicio físico e insatisfacción corporal en diferentes deportes de resistencia y su relación con la motivación al deporte. *Revista de Psicología Del Deporte*. 2016;25,113–120.
40. Devrim-Lanpir A, Zare R, Redha AA, Sandgren SS. Muscle dysmorphia and associated psychological features of males in the Middle East: A systematic review. *Performance Enhancement & Health*. 2023;11(3):100256 doi: 10.1016/j.peh.2023.100256.
41. Selvi K, Bozo Ö. The dark side of bodybuilding: the role of bodybuilding activities in compensation of frustrated basic psychological needs. *Motivation and Emotion*. 2020;44(2):190-208. doi: 10.1007/s11031-019-09805-6
42. Greenway CW, Price C. Muscle dysmorphia and self-esteem in former and current users of anabolicandrogenic steroids. *Performance Enhancement & Health*. 2020;7(3-4):100154.
43. Murray SB, Rieger E, Hildebrandt T, et al. A comparison of eating, exercise, shape, and weight related symptomatology in males with muscle dysmorphia and anorexia nervosa. *Body Image*. 2012;9(2):193-200. doi: 10.1016/j.bodyim.2012.01.008.
44. Compte EJ, Sepulveda AR, Torrente F. A twostage epidemiological study of eating disorders and muscle dysmorphia in male university students in Buenos Aires. *Eat Disord*. 2015;1092-1101. doi: 10.1002/eat.22448
45. Blashill AJ. Gender roles, eating pathology, and body dissatisfaction in men: a meta-analysis. *Body Image*. 2011;8(1):1-11. doi: 10.1016/j.bodyim.2010.09.002.
46. Ertl MM, Longo LM, Groth GH, et al. Running on empty: high self-esteem as a risk factor for exercise addiction. *Addiction Research & Theory*. 2018;26(3):205-211.

Death Anxiety Among Nursing Students After the February 6 Türkiye Earthquake: The Role of Earthquake Fear and Religious Coping

Seher ÇEVİK AKTURA*, Semiha DERTLİ**, Askeri ÇANKAYA***

Abstract

Aim: This study was conducted to examine the mediating role of religious coping in the effect of earthquake fear on death anxiety among nursing students affected by the 6 February earthquakes.

Methods: This descriptive and correlational study was conducted with 465 nursing students affected by the 6 February Earthquake. Research data were collected online via email and social networking sites (WhatsApp, Facebook, etc.) between 2 October and 1 December 2023. Data were obtained using the "Participant Introduction Form", "Earthquake Fear Scale", "Death Anxiety Scale" and "Religious Coping Styles Scale". The mediating role of religious coping in the effect of earthquake fear on death anxiety was assessed using path analysis.

Results: It was observed that earthquake fear had a significant and positive effect on positive religious coping ($\beta=0.126$, $p=0.006$) and that earthquake fear significantly increased death anxiety ($\beta=0.486$, $p<0.001$). In contrast, the effect of earthquake fear on negative religious coping ($\beta=0.087$, $p=0.059$) and the effects of positive or negative religious coping on death anxiety (positive: $\beta=0.000$, $p=0.995$; negative: $\beta=0.065$, $p=0.115$) were not statistically significant.

Conclusions: This study provides evidence for the development of educational programmes aimed at enhancing students' psychological resilience in disaster situations by revealing the effects of earthquake fear on death anxiety and religious coping among nursing students. Furthermore, the findings guide the planning of clinical interventions that support nurses' coping strategies for traumatic experiences and the integration of psychosocial support and religious coping skills into educational curricula.

Keywords: Death anxiety, earthquake, fear of earthquake, nursing students, religious coping styles.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 01.07.2025 Kabul / Accepted: 29.07.2026

DOI: <https://doi.org/10.38079/igusabder.1732153>

* Assoc. Prof., Inonu University, Faculty of Nursing, Department of Nursing Fundamentals, Malatya, Türkiye.

E-mail: seherrevk@gmail.com ORCID <https://orcid.org/0000-0001-7299-1788>

** Asst. Prof., PhD, RN, Malatya Turgut Özal University, Faculty of Health Sciences, Department of Nursing, Malatya, Türkiye. E-mail: semiha.dertli@ozal.edu.tr ; semihadertli15@gmail.com ORCID <https://orcid.org/0000-0003-0291-8045>

*** Asst. Prof., Fırat University, Faculty of Health Sciences, Department of Surgical Nursing, Elazığ, Türkiye.

E-mail: a.cankaya@firat.edu.tr ORCID <https://orcid.org/0000-0002-1637-3106>

ETHICAL STATEMENT: The research was approved by the Fırat University Social Humanities Ethics Committee (decision no: 2023/16, date: 31.08.2023) and conducted in accordance with the Declaration of Helsinki.

6 Şubat Türkiye Depreminden Etkilenen Hemşirelik Öğrencilerinde Deprem Korkusunun Ölüm Kaygısı Üzerindeki Etkisi: Dini Başa Çıkmanın Aracı Rolü

Öz

Amaç: Bu çalışma, 6 Şubat depremlerinden etkilenen hemşirelik öğrencilerinde deprem korkusunun ölüm kaygısı üzerindeki etkisinde dini başa çıkmanın aracılık rolünü incelemek amacıyla yapılmıştır.

Yöntem: Tanımlayıcı ve ilişkisel türdeki bu araştırma, 6 Şubat Depremi'nden etkilenmiş 465 hemşirelik öğrencisiyle yürütülmüştür. Araştırma verileri, 2 Ekim – 1 Aralık 2023 tarihleri arasında e-posta ve sosyal iletişim ağları (WhatsApp, Facebook vb.) aracılığıyla çevrim içi olarak toplanmıştır. Veriler; “Katılımcı Tanıtım Formu”, “Deprem Korkusu Ölçeği”, “Ölüm Kaygısı Ölçeği” ve “Dini Başa Çıkma Tarzları Ölçeği” kullanılarak elde edilmiştir. Deprem korkusunun ölüm kaygısı üzerindeki etkisinde dini başa çıkmanın aracılık rolü ise yol analizi yöntemiyle değerlendirilmiştir.

Bulgular: Deprem korkusunun pozitif dini başa çıkma üzerinde anlamlı ve pozitif bir etkisi olduğu ($\beta=0.126$, $p=0.006$) ve deprem korkusunun ölüm kaygısını anlamlı düzeyde artırdığı ($\beta=0.486$, $p<0.001$) görüldü. Buna karşılık, deprem korkusunun negatif dini başa çıkma üzerindeki etkisi ($\beta=0.087$, $p=0.059$) ve pozitif ya da negatif dini başa çıkmanın ölüm kaygısı üzerindeki etkileri (pozitif: $\beta=0.000$, $p=0.995$; negatif: $\beta=0.065$, $p=0.115$) istatistiksel olarak anlamlı bulunmamıştır.

Sonuç: Bu çalışma, hemşirelik öğrencilerinde deprem korkusunun ölüm kaygısı ve dini başa çıkma üzerindeki etkilerini ortaya koyarak, afet durumlarında öğrencilerin psikolojik dayanıklılığını artırmaya yönelik eğitim programlarının geliştirilmesi için kanıt sağlamaktadır. Ayrıca bulgular, hemşirelerin travmatik deneyimlerle başa çıkma stratejilerini destekleyecek klinik müdahaleler planlamasında ve eğitim müfredatlarında psikososyal destek ve dini başa çıkma becerilerinin entegrasyonunda yol gösterici niteliktedir.

Anahtar Sözcükler: Ölüm kaygısı, deprem, deprem korkusu, hemşirelik öğrencileri, dini başa çıkma tarzları.

Introduction

Natural disasters, particularly earthquakes, increase the likelihood of mental and behavioural disorders by instilling fear directly in individuals or by causing post-traumatic stress disorder¹. They also expose individuals to physical and psychological difficulties, leaving them vulnerable in their daily lives. People often experience various emotions such as anger, anxiety, sadness, and fear when faced with an unexpected situation²⁻⁴. A study conducted on survivors of the Van earthquake in Türkiye reported that the main factors affecting post-traumatic stress disorder were fear of future earthquakes and a reduced sense of control over life⁵. A study examining the initial effects of natural disasters on individuals who survived the 1999 İzmit earthquake in Türkiye reported that high levels of fear and anxiety were among the initial reactions of individuals⁶. Similarly, a study conducted after the 2015 Nepal earthquake indicated that post-traumatic stress disorder (PTSD) had a significant impact on individuals' mental health⁷. In a study examining the symptoms of post-traumatic stress disorder, depression, anxiety and other mental health problems following the 2010 earthquake in Haiti, it was found that the loss of life and property associated with the earthquake was

traumatic enough to trigger symptoms of PTSD, depression, anxiety and other mental health problems⁸.

The earthquakes measuring 7.7 and 7.6 on the Richter scale that struck Türkiye on 6 February caused devastating consequences. Repeated aftershocks further increased the scale of the destruction⁹⁻¹⁵. Formal education processes were interrupted due to the physical and psychological effects caused by the earthquake¹⁶. The occurrence of a major earthquake in the region and the perception of its potential recurrence can have significant psychological effects on individuals. This situation may lead students to reassess their perceptions of life and increase their anxiety levels. Nursing students psychologically affected by the earthquake may encounter various difficulties in their educational processes, professional development, and clinical practice.

When adapting to stressful events, individuals typically resort to various coping methods such as problem-focused coping, emotion-focused coping, and coping through religious beliefs to manage existing stress factors⁹. The coping methods used by students during this process can be decisive in managing the psychological effects they experience. Societies' religious and spiritual beliefs play an important role in understanding the meaning of natural disasters and determining how individuals should behave in such situations¹⁰.

In this context, religious coping emerges as an important coping mechanism that enables individuals to find hope, meaning and solutions in life, particularly when faced with difficult situations such as illness, pain or death¹¹. Religious coping refers to the process of seeking meaning and achieving inner balance by using religious references while dealing with stressful life events¹². Religious resources can strengthen individuals' ability to cope with stressful situations and adapt to them. Religious beliefs can be effective in reducing stress during crises such as death, injustice, and natural disasters, coping with life's uncertainties, and maintaining emotional balance. At the same time, they can instil a sense of hope in individuals, strengthening their belief that they can overcome difficulties and providing a sense of security. In addition, religious sources can contribute to strengthening individuals' social support networks. Therefore, it can be said that religious systems provide a multifaceted support mechanism for individuals¹³.

Studies conducted in this context indicate that religion and coping mechanisms may play an important role in post-disaster psychological processes. Indeed, it is stated that the factors affecting post-traumatic development in university students who experienced the 2016 Gyeongju earthquake were post-traumatic stress, resilience, religion, and gender. It is stated that nursing intervention programmes developed to support post-traumatic growth should be personalised according to gender and religious characteristics¹⁴.

Although there are studies in the literature on the psychological effects of natural disasters and religious coping, no studies have been found that specifically examine the relationships between earthquake fear, death anxiety, and religious coping among nursing students affected by the 6 February earthquakes, particularly within the framework of the mediation model. Therefore, it is thought that the findings obtained

from this study will contribute to the understanding of post-disaster psychological effects and will form an important basis for future studies aimed at determining the psychosocial support needs of nursing students.

The aim of this study is to examine the mediating role of religious coping styles in the effect of earthquake fear on death anxiety among nursing students affected by the 6 February earthquake in Türkiye. Path analysis and model fit indices were used to test earthquake fear and death anxiety mediated by positive and negative religious coping (Figure 1). Path analysis is a useful technique for testing relationships between variables¹⁷. The study examined the effect of earthquake fear on nursing students' death anxiety and the mediating role of religious coping methods using path analysis (Figure 1).

In this context, the study seeks to answer the following key research questions.

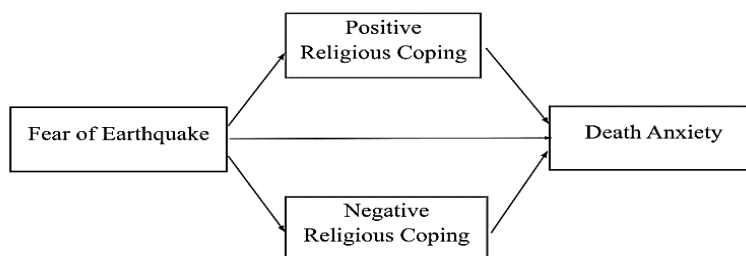
For nursing students affected by the earthquake:

Q1. What are the average scores for earthquake fear, death anxiety, and religious coping styles?

Q2. “Do earthquake fear, death anxiety, and religious coping levels differ according to nursing students’ sociodemographic and earthquake-related characteristics?”

Q3. Do positive and negative religious coping styles play a mediating role in the effect of earthquake fear on death anxiety?

Figure 1. Research model



Material and Methods

Study Design and Sample

This study was conducted in a descriptive-correlation-seeking design to examine nursing students' fear of earthquake, death anxiety and religious coping styles and the relationship between these variables. It was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines¹⁸.

This study was conducted with undergraduate nursing students in 11 provinces affected by the February 6 earthquake between October 2 and December 1, 2023. The population of the study consisted of students pursuing undergraduate nursing education in these provinces.

The inclusion criteria were: (1) being an undergraduate nursing student enrolled in one of the universities located in the provinces affected by the February 6 earthquake, (2) being between 18 and 30 years of age, (3) volunteering to participate in the study, and (4) completing the online questionnaire. Students who did not provide consent or submitted incomplete questionnaires were excluded from the study.

Due to the constraints of the disaster process, including limitations in transportation, time, and cost, the snowball sampling method, which is a non-random sampling technique, was used to reach participants. Data were collected through an online survey, and a total of 465 nursing students from 11 provinces participated in the study. The proportional distribution of participants across the provinces is presented in Table 1. Because there were no prior studies examining earthquake fear, death anxiety, and religious coping among nursing students in a similar disaster context, an appropriate effect size for conducting an a priori power analysis could not be determined during the study design phase. Therefore, after data collection was completed, a post-hoc power analysis was conducted using the G*Power v.3.1.9.7 program to evaluate whether the obtained sample size provided adequate statistical power. The power of the study was calculated as 0.99 (effect size = 0.412, α = 0.05), indicating that the sample size was sufficient.

Data Collection Tools

The data were collected using the Participant Introduction Form, Earthquake Fear Scale, Death Anxiety Scale and Religious Coping Styles Scale.

Participant Introduction Form: The form prepared by the researchers consisted of nine questions related to age, gender, grade, the place where the earthquake occurred, the province where the earthquake occurred, the university of study, loss and fear.

Earthquake Fear Scale (FES): The "Earthquake Fear Scale," originally created by Prizmić-Larsen, Vujčić, and Lipovčan (2023)¹⁹ to assess individuals' fear of earthquakes in the general population, was later culturally adapted into Turkish by Usta et al. (2023)⁴. This measurement tool is regarded as appropriate in terms of its conceptual framework, content relevance, and structural design. The scale features a unidimensional structure comprising seven items, explaining 65.8% of the total variance—a notably high rate for a single-factor tool. Responses are recorded using a 5-point Likert-type format, ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"). There are no reverse-coded items in the scale, and the total score is obtained by summing the responses to all items. The possible total score ranges from 7 to 35, with higher scores indicating a greater level of earthquake-related fear. The scale demonstrated high internal consistency, with a Cronbach's alpha of .91 in the original version and .89 in the current study^{4,19}.

Death Anxiety Scale (DAS): Initially developed by Templer in 1970²⁰, the scale was later adapted into Turkish by Akça and Köse (2008)²¹. This instrument includes 15 items, each answered with either "true" or "false." In the first nine items, a "Yes" response earns 1 point, while a "No" receives 0 points. In contrast, for the remaining six items, scoring is reversed—1 point is awarded for "No" responses and 0 for "Yes." The total score can range from 0 to 15, with higher scores reflecting greater levels of death anxiety. According to the scoring system: 0–4 points indicate a *mild* level, 5–9 points reflect a *moderate* level, 10–14 points suggest a *severe* level, and a score of 15 points corresponds to a *panic* level of death anxiety. The internal consistency of the scale, as measured by Cronbach's alpha, was reported as 0.76 in the original version, 0.80 in the Turkish adaptation, and 0.69 in the current study^{20,21}.

Religious Coping Styles Scale (RCSS): It was developed by Pargament et al.²² The scale divides religious coping into two categories: positive and negative. Positive religious coping includes cooperating with God, seeking spiritual support from God, making positive use of religious groups and activities, and offering religious help and forgiveness to others. Negative religious coping methods, on the other hand, include a weak and even angry relationship with God, attributing bad luck to the world and the meaning of life, questioning God's power, negative thoughts about religious groups, and attributing negative meanings to religion in difficult times²². The scale was validated in Turkish by Ekşi²³. The scale includes 14 Likert-type items that ask participants how they use coping skills when faced with stressful events in general. The positive subscale consists of seven items consisting of seven coping strategies such as religious benevolence and cooperative coping with religion. The other seven items assess negative religious coping strategies. The Cronbach's α coefficient of the positive religious coping factor was .97, .87 in this study; the Cronbach's α coefficient of the negative religious coping factor was .77, .72 in this study²⁴.

Data Collection

Data were collected through an online survey distributed to participants via email and social media (e.g., WhatsApp, Facebook) between October 2 and December 1, 2023. Students were able to access the survey questions after accepting an informed consent form explaining the purpose of the study. IP control was used in the online survey system to reduce the possibility of duplicate responses. A total of 465 responses were obtained during the data collection process. Incomplete surveys were excluded from the analysis, and only fully completed forms were included in the final dataset. Completing the data collection forms took approximately 8–10 minutes. All online completed forms were securely stored and backed up by the researchers.

Ethical Statement

The research was approved by the Firat University Social Humanities Ethics Committee (decision no: 2023/16, date: 31.08.2023) and conducted in accordance with the Declaration of Helsinki. Students were first informed about the research by reading the informed consent text explaining the purpose and rationale of the research in the link

sent over the internet. They were informed that they could withdraw from the study at any time without any justification. Then, they continued to fill in the questionnaire or withdrew from the study by selecting 'yes' or 'no' to the question 'Would you like to participate voluntarily in this study?'

Data Analysis

Data were collected using a Google Forms-based questionnaire and initially processed in Microsoft Excel. For statistical analysis, SPSS for Windows version 26.0 (IBM Corp., Armonk, NY, USA) was employed. Descriptive statistics such as percentages, means, standard deviations, medians, and minimum and maximum values were reported. The Shapiro-Wilk test was conducted to assess the normality of data distribution. For comparisons between two independent groups with normally distributed data, the independent samples t-test was used. One-Way ANOVA was applied for comparisons among three or more groups with normal distribution, while the Mann-Whitney U test was used for two-group comparisons when normality assumptions were not met.

The associations between earthquake fear, death anxiety, and religious coping were analyzed using Pearson correlation. To examine the mediating effect, IBM AMOS version 24 was used. Normality was further assessed through multivariate normality assumptions. Path analysis was conducted to test the proposed model, employing the Maximum Likelihood (ML) estimation method. The bootstrap resampling technique was used to assess the significance of the mediating role, with 2,000 bootstrap samples applied. A significance level of $p < 0.05$ was considered for all statistical analyses.

Results

The study revealed that the average age of nursing students was 20.75 ± 2.67 years, 75.9% of them were female and 32.7% of them were first-year students. It was found that 24.7% of the students experienced the earthquake in Elazığ province and 65.2% in their own homes. In addition, 5.6% of nursing students or at least one member of their family was trapped under the rubble, 3.4% lost at least one member of their family or relatives, and 57.2% reported no damage to their homes (Table 1).

Table 1. Descriptive characteristics of nursing students and their views on earthquake

Variables	$\bar{X} \pm SS$	Med (Min-Max)
Age	20.75 ± 2.67	20.0 (17.0-44.0)
	n	%
Gender		
Female	353	75.9
Male	112	24.1
Grade		
Freshman	152	32.7
Sophomore	105	22.6

Junior	147	31.6
Senior	61	13.1
Province where the earthquake happened		
Adana	6	1.3
Adıyaman	30	6.5
Diyarbakır	101	21.7
Elazığ	115	24.7
Gaziantep	55	11.8
Hatay	7	1.5
Kahramanmaraş	50	10.8
Kilis	10	2.2
Malatya	63	13.5
Osmaniye	5	1.1
Şanlıurfa	23	4.9
Earthquake Location		
In my own home	303	65.2
At the home of my family/relatives	162	34.8
The situation of you or a family member being trapped under debris during an earthquake		
Yes	26	5.6
No	439	94.4
Death of a family member or close relative in an earthquake		
Yes	16	3.4
No	449	96.6
Damage/collapse of the house in an earthquake		
Yes, it is damaged, but we live in it	143	30.8
Yes, our house was destroyed, we live in a tent/container	22	4.7
Our house was destroyed, we live with others	34	7.3
Our house was not damaged/ destroyed	266	57.2
Experiencing fear of another earthquake		
Yes	412	88.6
No	53	11.4

It was found that the mean FES score of nursing students was 23.47 ± 7.10 , the mean DAS score was 8.16 ± 2.85 , the mean P-RCSS score was 24.12 ± 4.12 and the mean N-RCSS score was 11.87 ± 3.91 (Table 2).

Table 2. Mean scores of fear of earthquake, death anxiety and religious coping styles scales of nursing students

Scales	$\bar{X} \pm SS$	Med(Min-Max)
FES	23.47±7.10	24(7-35)
DAS	8.16±2.85	9(1-13)
RCSS		
P-RCSS	24.12±4.12	25(7-28)
N-RCSS	11.87±3.91	11(7-28)

FES (Fear of Earthquake Scale), DAS (Death Anxiety Scale), RCSS (Religious coping styles scale), P-RCSS (Positive religious coping sub-dimension), N-RCSS (Negative religious coping sub-dimension)

It was determined that the mean scores of FES, DAS and P-RCSS were higher in female students ($p < .05$), the mean scores of P-RCSS were higher in those who were not trapped under the rubble in the earthquake ($p < .05$), and the mean scores of both FES and DAS were significantly higher in students who were afraid of another earthquake ($p < .05$) (Table 3).

Table 3. Comparison of the descriptive characteristics of nursing students and their mean scores on the Fear of Earthquake, Death Anxiety and Religious Coping Styles Scales

Variables	FES	DAS	RCSS	
			P-RCSS	N-RCSS
	$\bar{X} \pm SS$	$\bar{X} \pm SS$	$\bar{X} \pm SS$	$\bar{X} \pm SS$
Gender				
Female	25.17±6.23	8.59±2.70	24.53±3.67	11.66±3.85
Male	18.14±7.07	6.82±2.91	22.83±5.09	12.43±4.06
$t^{\#}/p$	9.41/ <0.001	5.93/ <0.001	3.28/ .001	-1.83/ .067
Grade				
Freshman	22.39±7.17	7.98±2.95	24.29±3.57	11.47±3.33
Sophomore	23.43±7.07	8.29±2.94	23.92±4.37	11.87±3.44
Junior	25.17±6.23	8.29±2.67	23.89±4.61	11.89±4.36
Senior	18.14±7.07	8.06±2.89	24.60±3.69	12.62±4.76
F^{∞}/p	2.512/ .058	.403/ .751	.605/ .612	1.269/ .284
Earthquake Location				
In my own home	22.99±7.00	8.09±2.89	24.13±4.13	11.95±4.07
At the home of my family/relatives	24.38±7.23	8.29±2.77	24.09±4.10	11.64±3.60
$t^{\#}/p$	-2.015/ .044	-.722/ .471	.099/ .921	.827/ .409
The situation of you or a family member being trapped under debris during an earthquake				
Yes	22.69±7.67	7.84±3.15	21.69±5.12	11.69±3.88
No	23.52±7.07	8.18±2.83	24.26±4.01	11.85±3.92
U^{β}/p	-.441/ .659	-.245/ .807	-2.700/ .007	-.190/ .849

Death of a family member or close relative in an earthquake				
Yes	22.31±8.04	7.25±3.17	24.75±3.39	10.68±3.30
No	23.51±7.07	8.19±2.83	24.10±4.14	11.88±3.93
U^{β}/p	-.522/ .602	-1.095/ .274	-.528/ .598	-1.135/ .256
Damage/collapse of the house in an earthquake				
Yes, it is damaged, but we live in it	23.58±6.75	8.12±2.83	24.09±4.04	11.84±3.79
Yes, our house was destroyed, we live in a tent/container	22.63±8.07	8.77±3.11	23.86±4.37	12.40±3.64
Our house was destroyed, we live with others	24.82±6.84	8.05±2.88	22.35±4.68	10.52±3.65
Our house was not damaged/destroyed	23.31±7.22	8.15±2.84	24.39±4.02	11.96±4.01
t^{∞}/p	.565/ .638	.358/ .783	2.523/ .057	1.527/ .207
Experiencing fear of another earthquake				
Yes	24.72±6.17	8.58±2.63	24.26±3.97	11.82±3.84
No	13.79±6.46	4.94±2.42	23.00±4.99	12.05±4.46
U^{β}/p	- 9.114/ <0.001	- 8.051/ <0.001	-1.303/ .193	-.214/ .830

t^{∞} : Independent Sample t-test, U^{β} : Mann Whitney U test, F^{∞} : One-Way ANOVA test

Table 4 examines the relationship between the mean scores of the Fear of Earthquake Scale (FES), Death Anxiety Scale (DAS), Positive Religious Coping Styles Scale (P-RCSS), and Negative Religious Coping Styles Scale (N-RCSS) among nursing students. A moderate relationship was found between fear of earthquake and death anxiety ($r = .492$, $p < 0.001$) and a weak positive relationship between fear of earthquake and positive religious coping ($r = .126$, $p = 0.007$). In addition, a weak positive relationship was observed between death anxiety and negative religious coping ($r = .107$, $p = 0.021$) (Table 4).

Table 4. The correlation between nursing students' FES, DAS, and RCSS scores

Scales		FES	DAS
FES	r	—	
	p		
DAS	r	.492**	-
	p	<0.001	
RCSS			
P-RCSS	r	.126*	.072
	p	.007	.121
N-RCSS	r	.087	.107*
	p	.060	.021

FES (Fear of Earthquake Scale), DAS (Death Anxiety Scale), RCSS (Religious coping styles scale), P-RCSS (Positive religious coping sub-dimension), N-RCSS (Negative religious coping sub-dimension) r (Pearson correlation test); * $p < .05$, ** $p < .001$

Table 5. Path analysis results

Dependent variable	Independent variable	β_1	β_2 (%95 CI)*	SE	t	p	R ²
		Direct Effect					
Religious coping-positive	Fear of earthquake	.126	.073(.013: .134)	.027	2.736	.006	.016
Religious coping-negative	Fear of earthquake	.087	.048(-.003: .102)	.025	1.889	.059	.008
Death anxiety	Religious coping-negative	.065	.047(-.023: .12)	.030	1.576	.115	.246
Death anxiety	Religious coping-positive	.000	.000(-.056: .056)	.028	0.006	.995	
Death anxiety	Fear of earthquake	.486	.195(.162: .227)	.016	11.944	<0.001	
		Total Effect					
Death anxiety	Fear of earthquake	.492	.197 (.166: .228)	.016	12.176	<0.001	.242
		Indirect Effect					
		β^1	β^2 (%95 CI)*	p		β^2	
Fear of death --> Religious coping-positive -> Death anxiety		<0.001	<0.001 (-.005: .004)	.971		<.001	
Fear of death --> Religious coping-negative -> Death anxiety		.006	.002 (-.001: .009)	.119		.006	

β_1 : Standardized path coefficient, β_2 : Non-standardized path coefficient, *Bootstrap 95% Confidence Interval

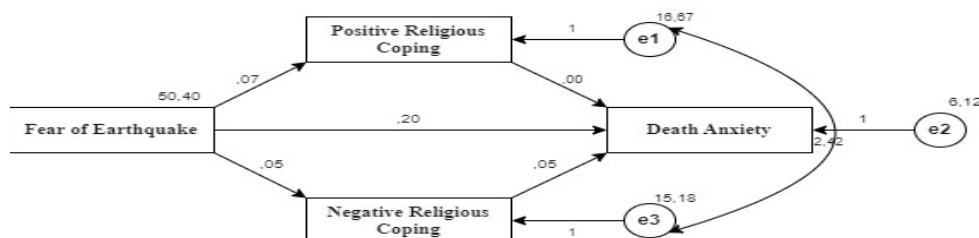
In the Multivariate Normality Test, the critical value was determined to be 8.381. This result is excellent since it is below 10; however, research has shown that values up to 20 are generally not problematic. Given that the assumption of multivariate normality was

satisfied, Maximum Likelihood (ML) was utilized as the method of calculation. When the model fit indices were examined, since the model was a just-identified (saturated) model, the values were obtained as GFI = 1.000, IFI = 1.000, CFI = 1.000, and SRMR = 0.000. The presence of a multicollinearity problem among the variables in the model was evaluated based on the correlation coefficients between the variables. The correlation coefficients ranged between .072 and .492; since these values are below .85, it was concluded that there is no multicollinearity problem in the model.

The analysis revealed that fear of earthquake had a statistically significant positive effect on the positive religious coping score ($p = .006$), with a one-point increase in earthquake fear score resulting in a .073-point increase in positive religious coping score. Additionally, fear of earthquake had a positive effect on death anxiety ($p < .001$), where a one-point increase in earthquake fear score leads to a .195-point increase in death anxiety. However, fear of earthquake had no significant effect on negative religious coping ($p = .059$). Neither positive nor negative religious coping variables significantly influenced death anxiety (p -values of .115 and .995, respectively). Positive and negative religious coping, along with fear of earthquake, explained 24.6% of the variance in death anxiety. When the total effect was examined, fear of earthquakes was found to have a statistically significant positive effect on death anxiety ($p < 0.001$). A one-unit increase in fear of earthquakes increased death anxiety by .197 points. Fear of earthquakes explained 24.2% of the variance in death anxiety. The mediating role of positive religious coping in the effect of fear of earthquake on death anxiety was not statistically significant ($p=0.971$). The mediating role of negative religious coping in the effect of fear of earthquake on fear of death was not statistically significant ($p=0.119$) (Table 5, Figure 2).

When the indirect effects of the mediation analysis were examined, the indirect effect of fear of earthquakes on death anxiety through positive religious coping was found to be statistically non-significant ($\beta_1 = 0.000$; $\beta_2 = 0.000$; 95% bias-corrected CI = -0.005 to 0.004 ; $p = 0.971$). Similarly, the indirect effect of fear of earthquakes on death anxiety through negative religious coping was also not statistically significant ($\beta_1 = 0.006$; $\beta_2 = 0.002$; 95% bias-corrected CI = -0.001 to 0.009 ; $p = 0.119$). The fact that the confidence intervals included zero for both indirect effects indicates that positive and negative religious coping did not play a significant mediating role in the relationship between fear of earthquakes and death anxiety (Table 5).

Figure 2. Tested Model-Non-standardized path coefficients



Discussion

In the study conducted to examine the mediating role of religious coping in the effect of fear of earthquake on death anxiety in nursing students affected by the 6 February earthquake in Türkiye, it was found that there was a positive relationship between students' fear of earthquake and death anxiety. The study found that there was no mediating role of religious coping in the effect of earthquake fear on death anxiety.

The study examined how demographic and earthquake-related characteristics influenced fear, death anxiety, and religious coping. Female students reported higher levels of earthquake fear, death anxiety, and positive religious coping compared with male students, suggesting that gender may play a role in emotional and coping responses to disaster. Students who were not trapped under rubble reported higher positive religious coping scores. This finding should be interpreted cautiously, as it may reflect an association between trauma exposure and coping strategies rather than a direct effect. Similarly, students who reported fear of another earthquake demonstrated significantly higher fear and death anxiety scores, suggesting a relationship between ongoing perceived risk and psychological responses. Overall, these findings indicate that individual characteristics such as gender, prior traumatic exposure, and perceived threat may be associated with variations in emotional responses and coping mechanisms among nursing students following a disaster. However, due to the cross-sectional nature of the study, causal inferences cannot be made. These results underscore the potential importance of considering these variables when planning psychosocial support interventions.

In the present study, nursing students reported moderate levels of earthquake and death-related fear, high levels of positive religious coping, and low levels of negative religious coping. These findings are consistent with previous literature indicating that fear is one of the most immediate and fundamental emotional responses following an earthquake, often accompanied by a diminished sense of control^{5,24}. Persistent fear in the period following a disaster has been shown to negatively affect individuals' mental health²⁵. Evidence from disaster-affected regions further illustrates how such emotional responses can influence both personal and professional functioning. For example, following the series of major earthquakes in the Canterbury region beginning in September 2010, nurses and nursing students experienced significant disruptions in their daily lives, including damaged homes, transportation difficulties, and family instability. Within this context, they were required to balance educational and professional responsibilities while simultaneously coping with heightened anxiety and fear²⁶. Together, these findings suggest that disaster-related fear among nursing students should be understood not only as an immediate emotional reaction but also as a broader psychosocial experience shaped by disruptions in daily life and emerging professional identities. Unlike the general population, nursing students occupy a dual position as both disaster survivors and future healthcare providers, which may intensify their emotional burden while simultaneously shaping their coping responses. Although limited research has quantitatively examined earthquake-related fear using standardized measurement

tools, existing studies indicate that prior exposure to earthquakes plays a critical role in shaping individuals' fear perceptions. For instance, individuals who have previously experienced earthquakes tend to report higher levels of fear compared with those who have not been exposed^{27,28}. Evidence from post-disaster contexts also suggests that these fears may persist over time. One study found that even one year after a disaster, young survivors continued to report fears related to vibrations, new earthquakes, loud noises, and buildings²⁹. Together, these findings indicate that earthquake experiences can generate enduring fear responses that may continue long after the immediate disaster period. In addition to disaster-related fear, death anxiety represents another significant psychological response among survivors of natural disasters. Repeated aftershocks and the uncertainty surrounding large earthquakes may intensify individuals' awareness of mortality³⁰. Empirical findings support this pattern; for example, research conducted after the 2012 earthquake in eastern Azerbaijan and Iran reported death anxiety levels above the moderate range³¹. Similarly, long-term qualitative evidence suggests that themes related to death anxiety may continue to influence survivors even a decade after the earthquake³². These findings highlight the lasting psychological impact of disaster experiences, particularly in relation to existential concerns. For nursing students, heightened death anxiety may have additional implications beyond personal distress. As individuals preparing for professional roles that involve caring for critically ill and dying patients, increased awareness of mortality may intersect with their developing professional identity and clinical preparedness. Therefore, understanding death anxiety in this population is important for developing educational and psychosocial support strategies that help nursing students cope with existential distress in both disaster and clinical care contexts.

Religious belief and coping mechanisms also play an important role in shaping how individuals interpret and emotionally respond to disasters. Religion can influence risk perception, guide behavioral responses, and serve as a psychosocial resource that helps survivors cope with trauma and emotional distress³³. Qualitative evidence supports this perspective; for example, Afghan refugees were found to rely on Islamic concepts, beliefs, and rituals as coping mechanisms in response to traumatic experiences³⁴. Quantitative studies conducted after major earthquakes similarly demonstrate the role of religious coping strategies. Following the 2010 Chile earthquake, survivors reported high levels of positive religious coping and low levels of negative religious coping³⁵, while moderate levels of religious coping were reported after the Nepal earthquake⁷. Consistent with these findings, the present study indicates that nursing students who survived an earthquake experienced both earthquake-related fear and death anxiety while predominantly utilizing positive religious coping strategies. In this specific population, positive religious coping may function not only as a personal resource but also as a meaning-making framework that supports emotional regulation during a period of academic and professional formation.

In their research on Muslim refugees, Taufik and Ibrahim reported that religious coping, primarily rooted in positive thinking towards God, offers protective effects and promotes acceptance in the face of traumatic experiences³⁶. Similarly, studies indicate that

religious interpretations often constitute a central cultural response to earthquakes, with religion frequently serving as a source of comfort for survivors³⁷. Within the context of nursing students, who are simultaneously navigating personal trauma and professional role development, such religious coping strategies may represent not only a general cultural response but also a personal meaning-making resource that supports emotional stability during their educational formation.

Consistent with this perspective, the present study found that levels of death anxiety and positive religious coping increased as earthquake fear increased. In other words, students who reported higher earthquake fear were more likely to use positive religious coping strategies. Religious coping did not mediate the relationship between earthquake fear and death anxiety, suggesting that although students frequently use positive religious coping, it may not be sufficient to reduce existential anxiety in this context.

This absence of a mediating effect should be considered a meaningful finding rather than a null result alone. From a theoretical perspective, in culturally and religiously homogeneous groups such as the present sample, religious coping may function more as an immediate, direct emotional regulation strategy rather than a complex intermediary mechanism between fear and existential anxiety. This interpretation is consistent with Pargament's religious coping framework, which conceptualizes religion as a primary meaning-making and emotion-regulation system that can operate directly in response to stressors as well as through more complex coping pathways^{38,39}. In addition, this pattern may also reflect limitations related to measurement sensitivity, as standardized religious coping instruments have been noted to insufficiently capture culturally embedded and context-specific expressions of religiosity in coping processes⁴⁰. Furthermore, the cross-sectional design of the study limits the ability to capture mediation as a dynamic and time-dependent process, consistent with the transactional model of stress and coping, which emphasizes coping as an evolving process that changes over time in response to ongoing appraisal of stressors⁴¹. Taken together, these considerations suggest that the lack of mediation may reflect not only statistical outcomes but also underlying theoretical and methodological constraints.

These findings should be interpreted cautiously, as the cross-sectional design does not allow conclusions regarding directional or causal relationships. The absence of a mediating role may be related to several contextual and methodological factors. First, the participants were nursing students living in the same country and largely sharing a similar cultural and religious background. Such cultural homogeneity may have limited variability in religious coping styles, thereby reducing the likelihood of detecting a mediation effect. Additionally, coping processes—particularly those involving existential meaning-making—may evolve over time as individuals adapt to traumatic experiences. A single time-point measurement may therefore be insufficient to capture the dynamic interplay between earthquake fear, religious coping, and death anxiety. Future longitudinal studies conducted with more heterogeneous samples may provide a clearer understanding of these potential mediating mechanisms.

Importantly, these findings underscore that nursing students' psychological responses to disasters should be interpreted within the framework of their educational trajectory and emerging professional identity. As future healthcare providers who will care for critically ill and dying patients, their experiences of fear, death anxiety, and religious coping may carry implications not only for personal well-being but also for professional development and clinical preparedness. Accordingly, integrating disaster preparedness training, structured psychosocial support, and opportunities for reflective discussion on religious and existential coping into nursing curricula may help students manage fear and strengthen resilience in both disaster and clinical care contexts.

Limitations

This study has certain methodological limitations. Firstly, the collection of data via self-reporting and the use of a non-probability method such as snowball sampling carry a risk of selection bias, thereby limiting the generalisability of the results. The fact that participants belonged to a single religion and participated online on a voluntary basis may have led to an over-representation of individuals with a particular interest in the subject within the sample. Furthermore, although data were collected from 11 provinces affected by the earthquake, the distribution across provinces has low representativeness of the population. On the other hand, although the Cronbach's alpha coefficient (0.69) of the Death Anxiety Scale (DAS) used in the study falls within acceptable limits, caution should be exercised when interpreting the findings. A significant technical limitation is that the tested model has a fully specified (just-identified/saturated) structure. This situation has led to the goodness-of-fit indices (CFI, GFI, IFI = 1.000; SRMR = 0.000) yielding mathematically perfect results due to the degrees of freedom being zero ($df = 0$). Although these values indicate a perfect fit to the data, they do not provide empirical evidence for the model's theoretical validity. Therefore, in future studies, it is recommended that models with fewer parameters (over-identified) be tested in order to assess the model's discriminant validity more effectively.

Conclusion

The study revealed that the fear of death and positive religious coping levels of nursing students increased as the fear of earthquake increased, and religious coping did not mediate the relationship between earthquake fear and death anxiety. Therefore, health professionals and nurse educators may consider prioritizing the creation of safe, supportive, and trust-building environments for students and disaster-affected individuals rather than focusing on specific coping styles. It is extremely important that the fear of earthquakes and death anxiety experienced by nursing students as a result of earthquakes and possible aftershocks are recognized early and addressed through structured psychological support and educational guidance provided by nursing educators. The findings highlight the importance of addressing psychological responses such as fear and death anxiety among nursing students who experience disasters. In the context of nursing science, integrating disaster preparedness, psychological resilience, and coping strategies into nursing education may help students better manage the emotional impact of disaster experiences. Furthermore, developing comprehensive

psychosocial support programs within nursing education settings may contribute to strengthening students' ability to cope with disaster-related stress while preparing them for clinical environments where they may encounter trauma, loss, and death.

Future longitudinal and multi-center studies are recommended to further explore the mechanisms linking disaster-related fear, coping processes, and psychological outcomes in nursing students, as well as to evaluate the effectiveness of educational and psychosocial interventions aimed at improving resilience, preparedness, and emotional regulation in disaster contexts.

Funding: The authors received no financial support for the research, authorship, and/or publication of this article.

Declaration of Competing Interest: The authors have no funding or conflicts of interest to disclose.

Acknowledgement: We would like to thank all the participants.

REFERENCES

1. Bertinelli L, Mahé C, Strobl E. Earthquakes and mental health. *World Dev.* 2023;169:106283.
2. Ahorsu DK, Lin CY, Imani V, Saffari M, Griffiths MD, Pakpour AH. The fear of COVID-19 scale: development and initial validation. *Int J Ment Health Addict.* 2020;18:1-9.
3. Brief DJ, Bollinger AR, Vielhauer MJ, et al. Understanding the interface of HIV, trauma, post-traumatic stress disorder, and substance use and its implications for health outcomes. *AIDS Care.* 2004;16(1):97-120.
4. Usta G, Torpuş K, Kanbay Y, Çınar Özbay S. The Turkish adaptation of the fear of earthquake scale. *Nat Hazards.* 2023;1-14.
5. Salcioglu E, Ozden S, Ari F. The role of relocation patterns and psychosocial stressors in posttraumatic stress disorder and depression among earthquake survivors. *J Nerv Ment Dis.* 2018;206(1):19-26.
6. Kowalski KM, Kalayjian A. Responding to mass emotional trauma: A mental health outreach program for Turkey earthquake victims. *Saf Sci.* 2001;39(1-2):71-81.
7. Baral IA, Bhagawati KC. Post traumatic stress disorder and coping strategies among adult survivors of earthquake, Nepal. *BMC Psychiatry.* 2019;19:1-8.

8. Cénat JM, McIntee SE, Blais-Rochette C. Symptoms of posttraumatic stress disorder, depression, anxiety and other mental health problems following the 2010 earthquake in Haiti: A systematic review and meta-analysis. *J Affect Disord.* 2020;273:55-85.
9. Kula N. Earthquake and religious coping. *Hitit Univ J Theol Fac.* 2002;1(1):234-255.
10. Erdoğan B. Sociology of the earthquake: social and cultural dimensions of the February 6 disaster. *TRT Acad.* 2023;8(18):718-725.
11. Kadiroğlu T, Güdücü Tüfekci F, Kara A. Determining the religious coping styles of adolescents in Turkey during COVID-19. *J Relig Health.* 2021;60:3406-3417.
12. Pargament KI. The psychology of religion and coping: Theory, research, practice. New York, NY: Guilford Press; 1997.
13. Karagöz S. The mediating role of psychological resilience in the relationship between burnout and religious coping in nurses. *Hitit J Theol.* 2022;21(1):749-784.
14. Kim I, Oh WO. Predictors of posttraumatic growth among university students who experienced a recent earthquake. *Issues Ment Health Nurs.* 2019;40(2):176-184.
15. AFAD. Disaster and Emergency Management Presidency. <https://www.afad.gov.tr/>. Accessed October 8, 2023.
16. Yükseköğretim Kurulu. Measures taken to provide university facilities to our citizens affected by the earthquake. <https://www.yok.gov.tr/en/Sayfalar/news/2023/measures-taken-to-provide-university-facilities-to-our-citizens-affected-by-the-earthquake.aspx>. Accessed October 12, 2023.
17. Lleras C. Path analysis. In: Kempf-Leonard K, ed. *Encyclopedia of Social Measurement*. 1st ed. Amsterdam, Netherlands: Elsevier; 2005. p.163-197.
18. Cuschieri S. The STROBE guidelines. *Saudi J Anaesth.* 2019;13(1):31.
19. Prizmić-Larsen Z, Vujčić MT, Lipovčan LK. Fear of COVID-19 and fear of earthquake: multiple distressing events and well-being in Croatia. *Psychol Rep.* 2023;126(2):403-423.
20. Templer DI. The construction and validation of death anxiety scale. *J Gen Psychol.* 1970;82:165-174.

21. Akça F, Köse IA. Adaptation of death anxiety scale: a validity and reliability study. *J Clin Psychiatry*. 2008;11(1):7-16.
22. Pargament KI, Koenig HG, Perez LM. The many methods of religious coping: Development and initial validation of the RCOPE. *J Clin Psychol*. 2000;56(4):575-583.
23. Ekşi H. A research on the relationship between coping, religious coping and mental health: Comparison of education, theology and engineering faculty students [PhD thesis]. Uludağ University, Bursa, Turkey; 2001.
24. Khachadourian V, Armenian H, Demirchyan A, et al. A post-earthquake psychopathological investigation in Armenia: methodology, summary of findings, and follow-up. *Disasters*. 2016;40(3):518-533.
25. Satıcı SA, Okur S, Deniz ME, et al. The development and initial validation of the Earthquake Fear Scale: Its links to personality traits, psychological distress, harmony in life, and mental wellbeing. *Stress Health*. 2023;39:1-12.
26. Richardson SK, Richardson A, Trip H, et al. The impact of a natural disaster: Under- and postgraduate nursing education following the Canterbury, New Zealand, earthquake experiences. *High Educ Res Dev*. 2015;34(5):986-1000.
27. Kung YW, Chen SH. Perception of earthquake risk in Taiwan: Effects of gender and past earthquake experience. *Risk Anal*. 2012;32(9):1535-1546.
28. Tian L, Yao P, Jiang S. Perception of earthquake risk: A study of the earthquake insurance pilot area in China. *Nat Hazards*. 2014;74(3):1595-1611.
29. Azarian A, Skriptchenko-Gregorian V, Miller TW, Kraus RF. Childhood trauma in victims of the Armenian earthquake. *J Contemp Psychother*. 1994;24(2):77-85.
30. Rowney C, Farvid P, Sibley CG. I laugh and say I have ‘earthquake brain!’: resident responses to the September 2010 Christchurch earthquake. *NZJ Psychol*. 2014;43(2):4-13.
31. Daryayelal A, Pourhossein R. The effect of the emotional expression through writing on reducing the fear and anxiety in adolescent students saved from death quake in East Azerbaijan. *Eur Online J Nat Soc Sci*. 2016;5(3):606-617.
32. Qi J, FPRT. Chinese college students’ death cognition and its long-term changes after Wenchuan earthquake. *Omega*. 2023;87(2):401-423.
33. Sun L, Deng Y, Qi W. Two impact pathways from religious belief to public disaster response: findings from a literature review. *Int J Disaster Risk Reduct*. 2018;27:588-595.

34. Gokani R, Wiebe S, Sherzad H, Akesson B. “We’re looking for support from Allah”: a qualitative study on the experiences of trauma and religious coping among Afghan refugees in Canada following the August 2021 withdrawal. *Religions*. 2023;14(5):645.
35. García FE, Páez-Rovira D, Cartes Zurtia G, Neira Martel H, Reyes Reyes A. Religious coping, social support and subjective severity as predictors of posttraumatic growth in people affected by the earthquake in Chile on 27/2/2010. *Religions*. 2014;5(4):1132-1145.
36. Taufik T, Ibrahim R. Making sense of disaster: Affinity to God as a coping strategy of Muslim refugees in Central Sulawesi. *J Loss Trauma*. 2020;25(1):61-73.
37. Bentzen JS, Force ER. Did seismic activity lead to the rise of religions? *Econ Relig*. 2023;63-95.
38. Pargament KI. The psychology of religion and coping: Theory, research, practice. Guilford Press, 1997.
39. Pargament KI, Koenig HG, Perez LM. The many methods of religious coping: Development and initial validation of the RCOPE. *Journal of Clinical Psychology*. 2000;56(4):519–543.
40. Ano GG, Vasconcelles EB. Religious coping and psychological adjustment to stress: A meta-analysis. *Journal of Clinical Psychology* 2005;61(4):461–480.
41. Lazarus RS, Folkman S. Stress, appraisal, and coping. *Springer*. 1984.

From Pixels to Isolation: The Role of Game Type in the Connection between Video Game Addiction and Loneliness

Abdullah ATLI*, Sertan Hamza GÜR**, Yeliz YAZICI DEMİR***

Abstract

Aim: This research sought to explore whether the type of video game—interactive or non-interactive—acts as a moderator in the link between video game addiction and loneliness among university students. The main purpose of the present study was to determine whether the game type meaningfully alters the strength of this relationship.

Method: The sample consisted of 729 university students aged between 17 and 30 years (mean: 21.76±2.06). Participants completed the Video Game Addiction Scale and the UCLA Loneliness Scale, and were categorized according to their preferred game type (interactive vs. non-interactive). A quantitative research approach was employed, utilizing relational screening and causal-comparative designs. Moderation analysis was conducted using PROCESS macro Model 1 (Hayes, 2013) in SPSS, with 2000 bootstrap samples, to assess the role of game type in the relationship between video game addiction and loneliness.

Results: The results indicated a notable positive correlation between video game addiction and loneliness. Furthermore, this relationship was observed to be more pronounced among individuals who primarily engaged in non-interactive games. The analysis also demonstrated that game type served as a significant moderator in the association between gaming addiction and loneliness.

Conclusion: The results indicate that game type should be taken into account when examining the psychological and social consequences of gaming. Individuals who predominantly engage in non-interactive games may experience heightened levels of loneliness in association with problematic gaming behaviors. These findings contribute to a better understanding of how digital game characteristics can affect players' emotional and social well-being.

Keywords: Video game addiction, loneliness, game type, interactive game, college students.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 30.07.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1754617>

* Prof. Dr., İnönü University, Education Faculty, Psychological Counseling and Guidance, Malatya, Türkiye.

E-mail: abdullahatli@inonu.edu.tr [ORCID https://orcid.org/0000-0001-7504-484X](https://orcid.org/0000-0001-7504-484X)

** Asst. Prof. Dr., İnönü University, Education Faculty, Psychological Counseling and Guidance, Malatya, Türkiye.

E-mail: sertangur44@gmail.com [ORCID https://orcid.org/0000-0002-7401-7505](https://orcid.org/0000-0002-7401-7505)

*** Lecturer, Sinop University, Education Faculty, Psychological Counseling and Guidance, Sinop, Türkiye.

E-mail: y yazici@sinop.edu.tr [ORCID https://orcid.org/0000-0001-8277-9246](https://orcid.org/0000-0001-8277-9246)

ETHICAL STATEMENT: This study was approved by the İnönü University Institutional Ethics Committee (Approval No: 2019/8-3, Date: 11.04.2019).

Piksellerden İzolasyona: Video Oyunu Bağımlılığı ve Yalnızlık Arasındaki İlişkide Oyun Türünün Rolü

Öz

Amaç: Bu çalışmada, üniversite öğrencilerinde video oyunu bağımlılığı ile yalnızlık arasındaki ilişkide oyun türünün (etkileşimli/etkileşimsiz) düzenleyici rolünü incelemek amaçlanmıştır. Çalışmanın temel amacı, video oyunu türünün söz konusu ilişki üzerindeki etkisini ortaya koymaktır.

Yöntem: Araştırmanın örneklemini 17–30 yaş aralığında yer alan 729 üniversite öğrencisi oluşturmaktadır (Ort: 21,76±2,06). Katılımcılara Video Oyunu Bağımlılığı Ölçeği ile University of California Los Angeles (UCLA) Yalnızlık Ölçeği uygulanmış ve oynadıkları oyun türüne göre (etkileşimli vs. etkileşimsiz) sınıflandırma yapılmıştır. Araştırma kapsamında nicel araştırma yöntemi kullanılmış, ilişkisel tarama ve nedensel karşılaştırma modellerinden yararlanılmıştır. Veriler doğrultusunda oyun türünün video oyunu bağımlılığı ile yalnızlık arasındaki ilişkide düzenleyici etkisi, SPSS ortamında Hayes (2013) tarafından geliştirilen PROCESS makrosu Model 1 kullanılarak 2000 bootstrap örneği ile analiz edilmiştir.

Bulgular: Elde edilen bulgular, video oyunu bağımlılığı ile yalnızlık arasında pozitif yönde anlamlı bir ilişki olduğunu göstermiştir. Ayrıca, bu ilişkinin etkileşimsiz oyunları tercih eden katılımcılarda daha güçlü olduğu bulunmuştur. Oyun türü, bağımlılık ve yalnızlık arasındaki ilişkiyi anlamlı düzeyde etkilemiş ve düzenleyici değişken olarak işlev görmüştür.

Sonuç: Araştırma bulguları, oyun bağımlılığı ile yalnızlık arasındaki ilişkide oyun türünün dikkate alınması gerektiğini ortaya koymaktadır. Etkileşimsiz oyun türlerine yönelen bireylerde yalnızlık hissinin daha yoğun yaşanabileceği sonucuna ulaşılmıştır. Bu bulgular, dijital oyunların bireylerin sosyal ve duygusal yaşantılarına etkisini anlamada önemli bir katkı sunmaktadır.

Anahtar Sözcükler: Video oyun bağımlılığı, yalnızlık, oyun türü, etkileşimli oyun, üniversite öğrencileri.

Introduction

Globally, there are approximately 3.32 billion gamers actively playing video games, and that number continues to grow at an accelerating pace¹. Video games that appeal to such a large audience inevitably lead to an intensification of research into the possible effects of these games². While previous studies on this topic strongly suggest that video game addiction increases loneliness³⁻⁵, interactive games (i.e., when there is a real person) have gained popularity in the last decade. It is not clear whether games with people have the same effect.

Despite the abundance of research on video game addiction, reaching a universally agreed-upon definition remains challenging, primarily because, unlike substance-related addictions such as alcohol or drugs, it lacks clear and observable physical symptoms. There are two definitions that come to the fore in studies examining the effects of playing video games. The first is problematic video game playing behavior (PVG), which encompasses addiction-like behaviors that include experiences such as (i) loss of control over behavior, (ii) conflict with self and others, (iii) preoccupation with the game, and (iv) use of games for coping/mood modification and withdrawal symptoms⁶⁻⁹. American Psychological Association (APA)¹⁰ defines Internet gaming addiction as "excessive and compulsive gaming and the inability to control one's behavior

despite negative consequences." In studies based on both definitions, it is noted that one of the consequences of video game addiction is loneliness. In the literature, there are studies that examine the relationship between internet gaming addiction, loneliness, and participation in sports activities^{11,12}, the relationship between internet addiction, loneliness, and internet gaming addiction^{13,14}, the effects of loneliness, motivation, and family attitudes on game addiction¹⁵⁻¹⁸, as well as studies examining the effects of loneliness on game addiction¹⁹⁻²² and whether it effectively curbs gambling addiction²³⁻²⁵. It can be said that the relationship between loneliness and addiction is reciprocal, that is, loneliness is both a cause and a consequence of gaming addiction²⁶⁻²⁸. Reasons such as the ability to create the desired avatar (the gamer's reflection in the virtual world), the surreal world offered by the game changing according to the gamer's intervention and desire, and the mistakes made in video games that are easier to recover from than in real life, are some of the reasons for playing more video games. This results in the gamer's connection to real life to be more severed, and this process leads to loneliness^{29,30}. It is the ouroboros effect over the gamers' lives. Thus we would expect a positive relationship between video game addiction and loneliness.

Video games can be classified under many different labels depending on the platform on which they are played, the purpose of the game, the game content, and the number of people participating in the game³¹. Studies on this topic prefer to use classifications that are appropriate for the structure of their own variables rather than general classifications about video games³². For example, studies on aggression classify games as *violent and nonviolent*³³; while studies on social relationships classify them as *single-player and multiplayer*³⁴. Apart from these basic classifications, there are also common classifications as *online and offline games*^{35,36}. This difficulty in classifying game genres is due to the ever-changing nature of games³⁶. It is not possible to classify game types based on a single characteristic. In this study, we classified video games into *interactive games* (i.e., games that interact with real people) and *non-interactive games* (i.e., games that do not interact with real people) according to the nature of our research variables. With this classification, we aim to examine games in terms of their interactivity and non-interactivity, regardless of their content (e.g., strategy, action, intelligence, role-playing, etc.) or the platform used (e.g., Xbox, PC, tablet, etc.). The types of games discussed in our research in the context of interactive games cause gamers not to notice how time passes, because of the possibility of communicating with other gamers, and therefore have a stronger addictive effect³⁷⁻³⁹. In their study, Weibel et al.³⁴ found that individuals who play a game with a real person enjoy the game more and play longer. Similarly, studies show that collaboration and interpersonal interaction in the virtual environment increase game time^{40,41}. Lee and Kim¹⁶ state that the addiction factor is higher for interactive games played with family, friends, or acquaintances than for other games (i.e., non-interactive games). On the other hand, since communication in non-interactive games is one-way, the factors that motivate gamers to continue playing are due to the fact that the game continues in an endless cycle, rather than interaction with real people^{23,29}. Non-interactive games decrease social interaction and heighten loneliness, whereas interactive games reduce loneliness by enabling communication with real people, despite prolonged screen time. Two complementary theoretical frameworks help

explain why game type may moderate the relationship between gaming addiction and loneliness. First, Social Presence Theory proposes that the degree to which a communication medium conveys the sense of another person being genuinely present determines the quality of social exchange it affords. Applied to video games, interactive games — in which players engage in real-time with other human participants — generate a high level of social presence, fostering feelings of connection and belonging that may attenuate the isolating consequences of excessive play. Non-interactive games, by contrast, offer no such interpersonal channel; the player interacts solely with a pre-programmed environment, yielding low social presence and leaving the individual without the relational resources that might otherwise buffer against loneliness. Second, Social Identity Theory offers a complementary perspective by emphasizing that membership in social groups is a fundamental source of self-concept and psychological well-being. Interactive games frequently give rise to in-group identities — clans, guilds, or teams — through which players derive a sense of belonging, shared purpose, and social validation. These group-based bonds can mitigate the social deficits associated with problematic gaming. Non-interactive games, lacking structured group membership, do not provide equivalent identity-based social resources, potentially amplifying the loneliness experienced by those who game compulsively. Together, these two frameworks converge on the prediction that game type should moderate the addiction–loneliness relationship: the social presence and group identity afforded by interactive games are expected to weaken the positive association between gaming addiction and loneliness, whereas the absence of these features in non-interactive games is expected to strengthen it. Accordingly, we anticipate that game type will moderate the link between video game addiction and loneliness. In this study, we investigated the moderating role of game type in the relationship between gaming addiction and loneliness. First, we examined our initial hypothesis (H1), which proposed a positive association between video game addiction and loneliness. We anticipated that individuals with higher levels of gaming addiction would experience greater feelings of loneliness. Second, our second hypothesis (H2) suggested that the type of video game plays a moderating role in this relationship. More specifically, we expected that the connection between gaming addiction and loneliness would be stronger among those who primarily engage in non-interactive games.

Material and Methods

Research Design

This study employed a quantitative research approach to investigate whether the type of video game (interactive vs. non-interactive) moderates the relationship between video game addiction and loneliness among university students. The research was designed using a causal-comparative and correlational model, as it aimed to examine both the predictive relationship between variables and group-based differences without manipulating any experimental conditions.

Participants completed two standardized measurement tools: one assessing video game addiction and the other measuring perceived loneliness. Based on their reported gaming

preferences, participants were categorized into two groups: those who predominantly play interactive video games (e.g., multiplayer online games) and those who prefer non-interactive video games (e.g., single-player offline games).

The study then compared the strength and direction of the relationship between video game addiction and loneliness across these two groups. Statistical analyses, including moderation analysis, were conducted to determine whether game type significantly affected this relationship.

Participants

All participants provided informed consent prior to their participation. Initially, 741 students studying at a state university in the Eastern Anatolia region of Turkey were reached for the study. However, 12 of these participants were dropped from the study because they did not write down what games they played or whether they were interactive. Therefore, the final sample (sample) of the research consists of 729 participants (age range=17-30 years, $M_{age}=21.76$, $SD_{age}=2.06$). The participants' grade levels are grade 1 (n = 126; 17.3%), grade 2 (n=154; 21.1%), grade 3 (n=211; 28.9%), and grade 4 (n=238; 32.6%). Faculty distribution of participants, Faculty of Education (n=178; 24.4%), Faculty of Arts and Sciences (n=96; 13.2%), Faculty of Fine Arts (n=20; 2.7%), Faculty of Economics and Administrative Sciences (n=146; 20%), Faculty of Theology (n = 19; 2.6%), Faculty of Communication (n=15; 2.1%), Faculty of Engineering (n=132; 18.1%), Faculty of Health Sciences (n=91; 12.5%), and Sports Faculty of Sciences (n=32; 4.4%). All students had a smartphone and 81% had their own computer.

Measures

Demographic Questions: This form includes information about the gender, age, class and faculty of the participants, the video games they play and the types of these games. In order to determine the types of games played by the participants (i.e., interactive and non-interactive), “*Which video game have you been playing the most recently?*”, “*Do you play this game with real gamers?*” questions were asked and the games written as open-ended were classified by the authors. For example, if participants who played “Football Manager,” “Candy Crush,” “Age of Empires,” “Subway Surfers,” “Call of Duty,” or similar games stated that there were no other human players in the games, they were classified as players of “non-interactive games”; if participants who played “Counter-Strike,” “PUBG,” “PlayerUnknown’s Battlegrounds Mobile,” “League of Legends,” or similar games stated that there were other human players playing against them, they were classified as players of “interactive games.” Thus, video games were transformed into binary (dichotomous; non-Interactive code = 0, interactive code = 1) qualitative arguments for statistical analysis.

Game Addiction: The Game Addiction Scale–Short Form (OBÖ-SF;⁵⁴), which includes seven items, was employed to assess participants’ levels of gaming addiction. An example item is: “How often have you spent an increasing amount of time playing games during the past six months?” Each item was rated on a five-point Likert scale ranging from 1

(never) to 5 (very often). A total score was calculated, with higher scores reflecting greater levels of gaming addiction. Baysak et al.⁴² reported an internal consistency coefficient of $\alpha=.88$ for the scale, while in the current study, the reliability was found to be $\alpha=.72$.

Loneliness: Doğan et al.⁴³ Turkish validity and reliability studies were conducted and the scale consisting of 4 items was used. Sample item: “*I feel left out.*” The scale, which was developed as a 4-point Likert scale, is graded between 1 (not at all appropriate) and 4 (completely appropriate). A total score can be obtained from the scale, and the higher the score, the higher the individual's level of loneliness. On the other hand, Doğan et al.⁴³ found the internal consistency of the scale as $\alpha = .72$. In this study, we found the internal consistency coefficient of the scale as $\alpha=.77$.

Ethical Statement

This study was approved by the İnönü University Institutional Ethics Committee (Approval No: 2019/8-3, Date: 11.04.2019).

Results

All statistical analyses were performed using SPSS (Version 26.0). Moderation analysis was conducted using the PROCESS macro (Model 1; Hayes, 2013) with 2,000 bootstrap samples. Initially, 741 students studying at a state university in the Eastern Anatolia region of Turkey were reached for the study. However, 12 of these participants were dropped from the study because they did not write down what games they played or whether they were interactive. Therefore, the final sample (sample) of the research consists of 729 participants (age range = 17-30, $M_{age} = 21.76$, $SD_{age} = 2.06$). Data from all 729 participants were screened for missing values using listwise deletion; no missing data except the 12 of the participants mentioned above were identified. Multicollinearity was assessed via Variance Inflation Factor (VIF) values, all of which fell below the accepted threshold of 10, indicating no multicollinearity concern. Multivariate normality assumptions were evaluated using Mahalanobis distance, and skewness and kurtosis values were inspected; all variables fell within acceptable limits (skewness <3, kurtosis <10). Inspection of bivariate scatter plots confirmed the absence of multivariate outliers. The means, standard deviations, skewness, kurtosis values, and correlation coefficients of the study variables are presented in Table 1. As shown in Table 1, video game addiction is positively correlated with loneliness ($r = .22$, $p < .001$). Thus, Hypothesis 1 was supported.

Table 1. Mean, standard deviation, skewness, kurtosis and correlation coefficients of research data.

Variable	1	2	3
1. Video Game Type	-		
2. Video Game Addiction	.41**	-	
3. Loneliness	-.08*	.22**	-
M	.66	16.67	5.39
SD	0.74	5.34	1.88
Skewness	-	.673	1.234
Kurtosis	-	.081	.541
Range ^a	0-1	7-35	4-16

Note. ^a Range of possible scores. $n = 729$. Game type (Non-Interactive: 0, Interactive: 1), * $p < .05$, ** $p < .01$

Testing the Moderation Hypothesis

To test the moderator effect of the game type (Hypothesis 2) on the relationship between gaming addiction and loneliness, we used the PROCESS macro plug-in Model 1 (see Figure 1) developed by Hayes⁴⁵, which is a plug-in for SPSS.

Figure 1. Conceptual model examining the moderator effect of game type on the relationship between game addiction and loneliness.

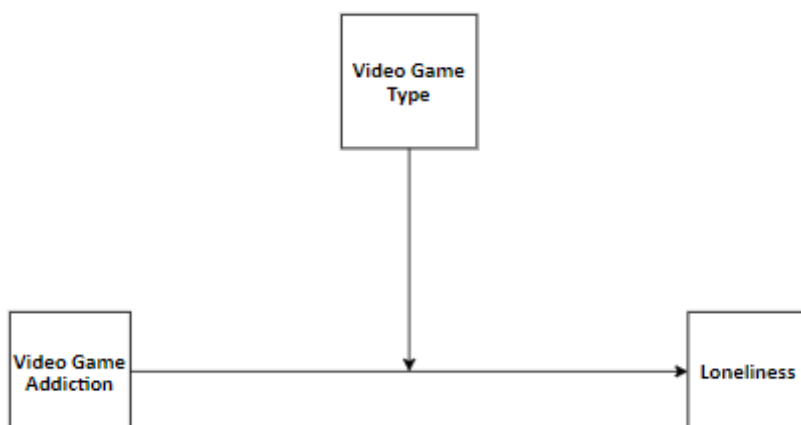


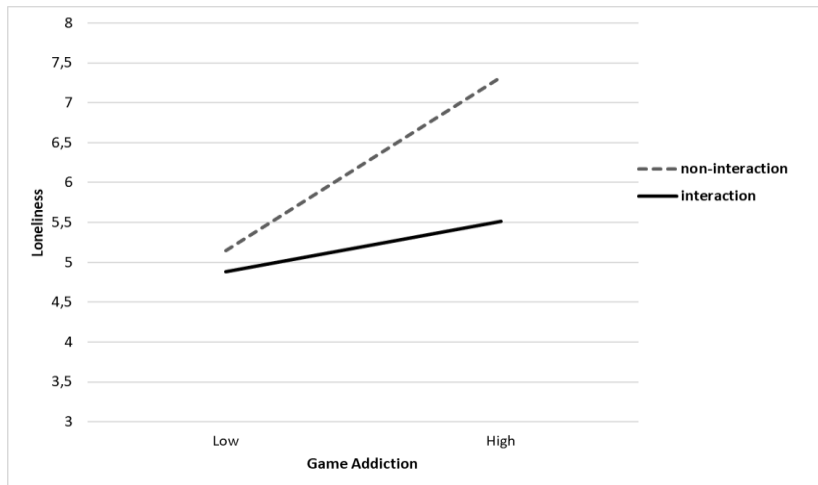
Table 2. The moderator effect of Game Type on the relationship between Video Game Addiction and Loneliness.

Outcome Variable Loneliness							
Model Summary							
	R	R ²	MSE	F	df1	df2	p
	.34	.11	3.16	30.96	3	725	.00
Modal		B	SE	t	p	LLCI	ULCI
Constant		2.84	.34	8.35	.00	2.175	3.51
Video Game Addiction		.2033	.02	8.64	.00	.157	.25
Game Type		1.3787	.46	2.99	.00	.473	2.28
Interaction (Video Game Addiction x Video Game Type)		-.1451	.02	-5.05	.00	-.201	-.09
Increase in R ² due to interaction							
	ΔR^2	F	df1	df2	p		
	.03	25.48	1	725	.00		
Conditional effects at moderator		B	SE	t	p	LLCI	ULCI
Non-Interactive		.20	.02	8.63	.00	.16	.25
Interactive		.06	.02	3.53	.00	.03	.09

Not: $n = 729$. Non-Interactive: 0, Interactive: 1. R^2 variance, ΔR^2 change in variance, MSE mean square error, SE standard error, $LLCI$ and $ULCI$ %95 bias corrected lower level confidence interval and upper interval, respectively (2000 bootstrap samples)

As can be seen in the results in Table 2, the variables video game addiction and game type significantly predict loneliness (overall model $R^2 = .11$, $F(3, 725) = 30.96$, $p < .01$). Moderation analyzes of the relationship between video game addiction and loneliness revealed that both video game addiction ($B = .203$, $SE = .02$, $p < .01$) and video game type ($B = 1.378$, $SE = 2.99$, $p < .01$) significantly predict loneliness and the interactive effect of game addiction and game type is also significant ($B = -.145$, $SE = -.5.05$, $p < .01$). When the conditional effect of game type on the relationship between video game addiction and loneliness is examined, non-interactive ($B = .20$, $SE = .02$, $p < .01$, CI [.16, .25]) and interactive ($B = .06$, $SE = .02$, $p < .01$, CI [.03, .09]) game types appear to have a significant effect. However, as can be seen in Figure 2, the significant relationship for both game types is stronger for the non-interactive game type. This result shows that hypothesis 2 stated in our study was confirmed.

Figure 2. Video Game Type as moderator of the relationships between video game addiction and loneliness.



Discussion

The aim of this study was to examine the potential moderating effect of game type on the relationship between video game addiction and loneliness. The results show that there is a positive relationship between loneliness and video game addiction and that game type has a moderating effect on this relationship. Research in this area has mainly focused on variables such as loneliness, violence, addiction, and psychological well-being in PVG or Internet gaming addiction. They classified the game types as multiplayer or single player games; brain teaser, strategy, violent and/or non-violent games. In this study, unlike previous studies, we classified video games into interactive and non-interactive game types. Thus, our study contribute to the literature in this regard.

Playing video games is an important part of many people's lives. As a result of game design and fiction, mixed with marketing strategies, a generation has emerged that lives in the world of games³⁸. For this reason, video game addiction affects every young person in the world in different ways and is not just a situation specific to a certain culture, geography, and/or age⁴⁶. On the other hand, Caplan et al.⁴⁶ found that Problematic Internet use is directly related to loneliness and that as addiction increases, so do loneliness, introversion, and depression. While loneliness significantly predicts problematic internet use^{47,48}, it is also claimed that PVG or internet gaming addiction increases loneliness⁴⁹⁻⁵². Although the connection between loneliness and video game addiction can be considered bidirectional, the meta-analysis conducted by Moretta and Buodo⁵¹ revealed that Internet gaming addiction predominantly leads to increased loneliness. In line with this finding, our first hypothesis proposed a positive association between video game addiction and loneliness, suggesting that higher addiction levels are linked to greater feelings of loneliness. This outcome is also consistent with Kanat's¹³ research, which similarly identified a positive correlation between digital game addiction and loneliness. Regarding our second hypothesis—that the relationship between gaming addiction and loneliness is moderated by game type—no studies directly employing the

same game-type grouping were identified in the existing literature. Nevertheless, when categorizing games, we adopted a distinction between interactive and non-interactive games, which diverges from more common classifications such as violent vs. non-violent or strategy vs. intelligence-based games. Prior research has noted, for example, that players of World of Warcraft—classified within multiplayer online role-playing games (MMORPGs)—tend to report lower levels of social anxiety and reduced feelings of loneliness, indicating the potential significance of game interactivity in psychological outcomes⁵³⁻⁵⁵. Similarly, Kaufman and Zhang⁵⁴ found that those who play live online games and feel a sense of belonging to a group while playing feel less lonely. The aforementioned studies show that games providing the opportunity to interact with real people prevent perceived loneliness. Unlike interactive games, non-interactive games by their nature do not involve real people and have a structure allowing the gamer to complete a task. In particular, with the increasing preference for non-interactive games in recent years¹, it is noticeable that non-interactive games with challenging tasks that can be accessed without the internet and that arouse curiosity are played longer. These studies show that non-interactive game types increase loneliness because they do not allow interaction with real people. Although there have been studies on the moderation of game types and aggression, impulsivity, and psychopathological outcomes⁴⁸, to our knowledge, our study is the first study on the moderation of game types to examine the relationship between loneliness and video game addiction. The groupings of game types are generally appropriate for the research character, such as strategy games (Warcraft, Ages of Empires, etc.), violent (Manhunt, Deadspace) and non-violent games (Flower, Stardew Valley), puzzle games (Tangram, Candycrash). In addition to interactive games, there are also non-interactive games within each group.

The results of the study should be interpreted in the context of its limitations. The data of the study is limited to one university in Eastern Anatolia Region Turkey. Although the study reached a large number of individuals, the generalizability of the current study may be considered limited given the self-reported data collection and the potential uniqueness of the sample characteristics. The fact that the study was not conducted in a cross-cultural setting makes it difficult to generalise the findings. Another limitation of this study is the use of cross-sectional data, which does not allow for inferences about temporal priority or causality. Future studies could plan a longitudinal study examining the interactions of middle school students and high school students, taking into account the age range.

Our research has found that the relationship between video game types and loneliness is moderated by the type of the games, and that the relationship between addiction and loneliness is particularly strong for non-interactive games. Video game addiction can disrupt the structure of social relationships and perceptions of the real world³⁶. Increased loneliness poses many dangers to gamers such as depression, aggressive and impulsive behavior, deterioration of family and friendship relationships, and academic failure as they attempt to overcome real-world interaction and the urge to belong to a group through games. Therefore, the need for protective and preventive counseling practices should be highlighted through psychological, psychiatric, sociological, and educational

studies on this topic. Considering that games are affecting more and more people of all ages and in every country, it is clear that video game addiction is becoming a problem that will affect more people in the future both in Turkey and worldwide. Consequently, our research has added a new framework to the studies in this field by investigating the moderating effect of video game type on the relationship between video game addiction and loneliness. In this way, it is shown that video game addiction, which has become normal for young people, is one of the pathological behaviors and is associated with mental disorders.

Conclusion

The present study highlights game type as an important contextual factor in understanding the relationship between video game addiction and loneliness among university students. Although higher levels of video game addiction were associated with greater loneliness in both game-type groups, this association was substantially stronger among individuals who predominantly played non-interactive games than among those who played interactive games. By distinguishing games according to whether they provide interaction with real people, the study offers an alternative perspective to conventional genre-based classifications and suggests that the social characteristics of gaming may be relevant to players' psychosocial well-being. Accordingly, prevention and counseling efforts addressing problematic gaming may benefit from considering not only the severity or duration of gaming but also the interpersonal characteristics of the games individuals play. Given the cross-sectional and self-report nature of the study, future longitudinal and cross-cultural research should further examine how game interactivity and related social processes shape the association between problematic gaming and loneliness over time.

AI Declaration

The authors used DeepL translation tools to support the translation of the manuscript from Turkish to English and subsequently reviewed the text carefully to ensure clarity and accuracy.

Acknowledgments and Funding

The authors thank all the participants who volunteered to participate the study. There is no funding in this study.

REFERENCES

1. Statista. Video gaming worldwide - statistics & facts.
<https://www.statista.com/topics/1680/gaming/?srsltid=AfmBOoolVolnUuCj2mZOeUOoeQE4Yxzn1cJbUT61c6TPdYUEgiYTQCdH> _Published February 27, 2026.
Accessed March 24, 2026

2. Childress MD, Braswell R. Using massively multiplayer online role-playing games for online learning. *Distance Education*. 2006;27(2):187-196.
3. Demir Y, Kutlu, M. The relationship between loneliness and depression: Mediation role of internet addiction. *Educational Process: International Journal*. 2016;5(2):97-105.
4. Erkoç MF, Özçakır F, Erkoç Ç. *Conference proceedings. The future of education*. libreriauniversitaria.it Edizioni. 2015.
<http://dx.doi.org/10.13140/RG.2.1.4456.5201>
5. Esen E, Siyez D. M. An investigation of psycho-social variables in predicting internet addiction among adolescents. *The Turkish Psychological Counseling and Guidance Journal*. 2011;4(36)127-136.
6. Colder Carras M, Porter AM, Van Rooij, et al. Gamers' insights into the phenomenology of normal gaming and game "addiction": A mixed methods study. *Computers in Human Behavior*. 2018;79:238-246. doi: 10.1016/j.chb.2017.10.029
7. King DL, Haagsma MC, Delfabbro PH, Gradisar M, Griffiths MD. Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools. *Clinical Psychology Review*. 2013;33(3)331-342. doi: 10.1016/j.cpr.2013.01.002
8. Van Rooij AJ, Schoenmakers TM, Van den Eijnden RJ, Vermulst AA, Van de Mheen D. Video game addiction test: Validity and psychometric characteristics. *Cyberpsychology, Behavior, and Social Networking*. 2012;15(9)507-511. doi: 10.1089/cyber.2012.0007
9. Van Rooij AJ, Meerkerk G, Schoenmakers TM, Griffiths M, Van de Mheen D. Video game addiction and social responsibility. *Addiction Research & Theory*. 2010;18(5)489-493.
10. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub. 2013.
11. Ekinçi NE, Yalcin I, Ayhan C. Analysis of loneliness levels and digital game addiction of middle school students according to various variables. *World Journal of Education*. 2019;9:1-20. doi: 10.5430/wje.v9n1p20
12. Rehbein F, Baier D. Family-, media-, and school-related risk factors of video game addiction. *Journal of Media Psychology*. 2013;25(3):118-128.
13. Kanat, S. The relationship between digital game addiction, communication skills and loneliness perception levels of University students. *International Education Studies*. 2019;12(11): 80-93. doi: 10.5539/ies.v12n11p80

14. Odacı H, Çelik ÇB. Who are problematic internet users? An investigation of the correlations between problematic internet use and shyness, loneliness, narcissism, aggression and self-perception. *Computers in Human Behavior*. 2013;29(6):2382-2387.
15. Chung S, Lee J, Lee HK. Personal factors, internet characteristics, and environmental factors contributing to adolescent internet addiction: A public health perspective. *International Journal of Environmental Research and Public Health*. 2019;16(23)4635-4648. doi: 10.3390/ijerph16234635
16. Lee J, Ko DW, Lee H. Loneliness, regulatory focus, inter-personal competence, and online game addiction. *Internet Research*. 2019;29;2;381-394. doi: 10.1108/intr-01-2018-0020
17. Zhang S, Tian Y, Sui Y, et al. Relationships between social support, loneliness, and internet addiction in Chinese postsecondary students: A longitudinal cross-lagged analysis. *Frontiers in Psychology*. 2018;9. doi: 10.3389/fpsyg.2018.01707
18. Jeong EJ, Kim DJ, Lee DM, Lee HR. A study of digital game addiction from aggression, loneliness and depression perspectives. *2016 49th Hawaii International Conference on System Sciences (HICSS)*. 2019. doi: 10.1109/hicss.2016.470
19. Pontes HM, Patrão IM, Griffiths MD. Internet addiction test--Portuguese version. *PsycTESTS Dataset*. 2014;32(1):91-98. doi: 10.1037/t63973-000
20. Wang Y. The impact of interparental conflicts on online game addiction symptomatology: The mediating roles of the parent-adolescent relationship and loneliness in adolescents. *Psychological Reports*. 2021;1:20. doi: 10.1177/00332941211016751
21. Şahin M, Keskin S, Yurdugül H. Impact of family support and perception of loneliness on game addiction analysis of a mediation and moderation. *International Journal of Game-Based Learning*. 2019;9(4):15-30. doi: 10.4018/ijgbl.2019100102
22. Lemmens JS, Valkenburg PM, Peter J. Development and validation of a game addiction scale for adolescents. *Media Psychology*. 2009;12(1):77-95.
23. Wittek CT, Finserås TR, Pallesen S, Mentzoni RA, Hanss D, Griffiths MD. Prevalence and predictors of video game addiction: A study based on a national representative sample of gamers. *International Journal of Mental Health and Addiction*. 2015;14(5):672-686.
24. Doğan Keskin A, Aral N. Oyun bağımlılığı: güncel bir gözden geçirme. *Bağımlılık Dergisi*. 2021;22(3):327-339. doi: 10.51982/bagimli.880679

25. Wang J, Sheng J, Wang H. The association between mobile game addiction and depression, social anxiety, and loneliness. *Frontiers in Public Health*. 2019;7(1):1-6
26. Apperley TH. Genre and game studies: Toward a critical approach to video game genres. *Simulation & Gaming*. 2006;37(1):6-23. doi: 10.1177/1046878105282278
27. Braun B, Stopfer JM, Müller KW, Beutel ME, Egloff B. Personality and video gaming: Comparing regular gamers, non-gamers, and gaming addicts and differentiating between game genres. *Computers in Human Behavior*. 2016;55(1):406-412.
28. Sestir MA, Bartholow B. Violent and nonviolent video games produce opposing effects on aggressive and prosocial outcomes. *PsycEXTRA Dataset*. 2011.
29. Cole H, Griffiths MD. Social interactions in massively multiplayer online role-playing gamers. *CyberPsychology & Behavior*. 2007;10;4:575-583. doi: 10.1089/cpb.2007.9988
30. Madran H, Cakilci E. The relationship between aggression and online video game addiction: A study on massively multiplayer online video game players. *Anatolian Journal of Psychiatry*. 2014;15(2):99-107. doi: 10.5455/apd.39828
31. Elliott L, Golub A, Ream G, Dunlap E. Video game genre as a predictor of problem use. *Cyberpsychology, Behavior, and Social Networking*. 2012;15;3:155-161.
32. Griffiths M, Davies MN, Chappell D. Online computer gaming: A comparison of adolescent and adult gamers. *Journal of Adolescence*. 2004;27(1):87-96.
33. Peña J, Ghaznavi J, Brody N, et al. Effects of human vs. computer-controlled characters and social identity cues on enjoyment. *Journal of Media Psychology*. 2019;31(1):35-47.
34. Weibel D, Wissmath B, Habegger S, Steiner Y, Groner R. Playing online games against computer- vs. human-controlled opponents: Effects on presence, flow, and enjoyment. *Computers in Human Behavior*. 2008;24(5):2274-2291. doi: 10.1016/j.chb.2007.11.002
35. Eichenbaum A, Kattner F. The role of game genres and the development of internet gaming disorder in school- Aged children. *Journal of Addictive Behaviors, Therapy & Rehabilitation*. 2015;04(03):1-7. doi: 10.4172/2324-9005.1000141
36. Hussain Z, Griffiths MD, Baguley T. Online gaming addiction: Classification, prediction and associated risk factors. *Addiction Research & Theory*. 2011;20;5:359-371.

37. Kaye LK, Bryce J. Go with the flow: The experience and affective outcomes of solo versus social gameplay. *Journal of Gaming & Virtual Worlds*. 2014;6(1):49-60.
38. Ravaja N, Saari T, Turpeinen M, Laarni J, Salminen M, Kivikangas M. Spatial presence and emotions during video game playing: Does it matter with whom you play? *Presence: Teleoperators and Virtual Environments*. 2006;15;4:381-392. doi: 10.1162/pres.15.4.381
39. Hartevelde C, Bekebrede G. Learning in single-versus multiplayer games: The more the merrier? *Simulation & Gaming*. 2010;42(1):43-63. doi: 10.1177/1046878110378706
40. Wang C, Chan CL, Mak K, Ho S, Wong PW, Ho RT. Prevalence and correlates of video and internet gaming addiction among Hong Kong adolescents: A pilot study. *The Scientific World Journal*. 2014;1(1):1-9. doi: 10.1155/2014/874648
41. Guadagno RE, Blascovich J, Bailenson JN, Mccall C. Virtual humans and persuasion: the effects of agency and behavioral realism, media psychology. *Media Psychology*. 2007;10(1):1-22. doi: 10.1080/15213260701300865
42. Baysak E, Kaya FD, Dalgar I, Candansayar S. Online game addiction in a sample from Turkey: Development and validation of the Turkish version of game addiction scale. *Klinik Psikofarmakoloji Bülteni-Bulletin of Clinical Psychopharmacology*. 2016;26(1):21-31.
43. Doğan T, Çötök NA, Tekin EG. Reliability and validity of the Turkish version of the UCLA loneliness scale (ULS-8) among university students. *Procedia - Social and Behavioral Sciences*. 2011;15(1):2058-2062. doi: 10.1016/j.sbspro.2011.04.053
44. Weston R, Gore PA. A brief guide to structural equation modeling. *The Counseling Psychologist*. 2006;34(5):719-751. doi: 10.1177/0011000006286345
45. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Press. 2013.
46. Caplan S, Williams D, Yee N. Problematic internet use and psychosocial well-being among MMO players. *Computers in Human Behavior*. 2009;25(6):1312-1319.
47. Hu, C., Meng, X., Wang, X., & Huang, J. (2026). Reciprocal within-person dynamics between internet gaming disorder symptoms, physical activity, and loneliness among Chinese adolescent gamers: Three-wave prospective cohort study. *JMIR Serious Games*, 14, e87847. <https://doi.org/10.2196/8784>.
48. Mamun MA, Hossain S, Moonajilin MS, Masud MT, Misti JM, Griffiths M. Does loneliness, self-esteem and psychological distress correlate with problematic

internet use? A Bangladeshi survey study. *Asia-Pacific Psychiatry*. 2020;12(2):1-8

49. Simcharoen S, Pinyopornpanish M, Haoprom P, Kuntawong P, Wongpakaran N, Wongpakaran T. Prevalence, associated factors and impact of loneliness and interpersonal problems on internet addiction: A study in Chiang Mai medical students. *Asian Journal of Psychiatry*. 2018;31(1):2-7. doi: 10.1016/j.ajp.2017.12.017
50. Zeliha T. Internet addiction and loneliness as predictors of internet gaming disorder in adolescents. *Educational Research and Reviews*. 2019;14(3):465-473.
51. Moretta T, Buodo G. Problematic internet use and loneliness: How complex is the relationship? A short literature review. *Current Addiction Reports*. 2020;7(2):125-136.
52. Kök Eren H, Örsal Ö. Computer game addiction and loneliness in children. *Iranian Journal of Public Health*. 2018;47(10):1504-1510.
53. Visser M, Antheunis ML, Schouten AP. Online communication and social well-being: How playing world of Warcraft affects players' social competence and loneliness. *Journal of Applied Social Psychology*. 2013;43(7):1508-1517. doi: 10.1111/jasp.12144
54. Kaufman D, Zhang F. Can playing massive multiplayer online role playing games (MMORPGs) help older adults? *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health*. 2015;1:525-535. doi: 10.5220/0005551405270535
55. Hainey T, Connolly T, Stansfield M, Boyle E. The differences in motivations of online game players and offline game players: A combined analysis of three studies at higher education level. *Computers & Education*. 2011;57(4):2197-2211.

The Association between Synthetic Oxytocin Administration During Labor and Birth Interventions, Maternal Anxiety, and Newborn Stress Levels: A Comparative Study

Hatice Gül ÖZTAŞ*, Esra SABANCI BARANSEL **, Melek Nur KEÇELİ***

Abstract

Aim: The objective of this study was to examine the associations between synthetic oxytocin administration during labor, birth intervention rates, maternal anxiety levels, and newborn stress levels.

Method: This cross-sectional analytical study included 300 postpartum women divided into two groups: those who received synthetic oxytocin (n=197) and those who did not (n=103). Data were collected using the Personal Information Form, Labor Observation Form, State Anxiety Inventory (SAI), and Newborn Stress Scale (NSS). Multivariable regression analyses were performed to assess the independent associations while adjusting for potential obstetric and sociodemographic confounders.

Results: In unadjusted analyses, fundal pressure, placental retention, and episiotomy rates were higher in the synthetic oxytocin group ($p<0.05$). Women in this group also had higher SAI scores (51.43 ± 3.39 vs. 50.11 ± 3.54 , $p=0.040$). and higher newborn stress levels ($p=0.002$). After adjusting for potential confounders in multivariable logistic regression, synthetic oxytocin administration remained significantly associated with increased odds of episiotomy (OR=2.04, 95% CI: 1.02–4.00, $p=0.042$) and placental retention (OR=7.14, 95% CI: 1.49–33.33, $p=0.014$). However, multivariable linear regression models for maternal anxiety ($p=0.077$) and newborn stress ($p=0.052$) did not reach overall statistical significance, indicating that these specific factors should not be interpreted as independently associated with oxytocin administration.

Conclusion: The findings suggest that synthetic oxytocin administration is associated with higher rates of specific obstetric interventions such as episiotomy and placental retention. Due to overall model limitations, the independent relationships regarding maternal anxiety and neonatal stress should be interpreted with caution. Healthcare professionals should prioritize individualized, evidence-based labor management to minimize unnecessary medical interventions.

Keywords: Synthetic oxytocin, labor induction, maternal anxiety, newborn stress, birth interventions, midwifery.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 30.06.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1730302>

* Assoc. Prof., PhD, Kahramanmaraş Sütçü İmam University, Faculty of Health Sciences, Department of Midwifery, Kahramanmaraş, Türkiye. E-mail: h.gul_akbaba@hotmail.com [ORCID http://orcid.org/0000-0003-3574-2509](https://orcid.org/0000-0003-3574-2509)

** Asst. Prof., PhD, İnönü University, Faculty of Health Sciences, Department of Midwifery, Malatya, Türkiye.

E-mail: esraa.sabancii@gmail.com [ORCID http://orcid.org/0000-0001-6348-2084](https://orcid.org/0000-0001-6348-2084)

*** RM, Kahramanmaraş Necip Fazıl City Hospital, Department of Delivery Room, Midwifery, Kahramanmaraş, Türkiye.

E-mail: meleknurkeceli988@gmail.com [ORCID http://orcid.org/0009-0002-7212-4654](https://orcid.org/0009-0002-7212-4654)

ETHICAL STATEMENT: In order to conduct the study, ethical approval was obtained from Inonu University's Non-Interventional Research Ethics Committee (Decision number: 2025/7112; date: 04.02.2025).

Doğum Eylemi Sırasında Sentetik Oksitosin Uygulaması ile Doğum Müdahaleleri, Maternal Kaygı ve Yenidoğan Stres Düzeyleri Arasındaki İlişki: Karşılaştırmalı Bir Çalışma

Öz

Amaç: Bu çalışmanın amacı, doğum sürecinde uygulanan sentetik oksitosin kullanımı ile doğuma müdahale oranları, maternal kaygı düzeyi ve yenidoğan stres düzeyi arasındaki ilişkileri incelemektir.

Yöntem: Analitik kesitsel tasarıma sahip bu araştırmaya 300 postpartum kadın dahil edilmiş; katılımcılar sentetik oksitosin uygulananlar (n=197) ve uygulanmayanlar (n=103) olarak iki gruba ayrılmıştır. Veriler; Tanımlayıcı Bilgi Formu, Doğum Süreci Gözlem Formu, Durumluk Anksiyete Envanteri (STAI) ve Yenidoğan Stres Ölçeği (YSÖ) kullanılarak toplanmıştır. Olası karıştırıcı faktörler kontrol edilerek bağımsız ilişkileri değerlendirmek amacıyla çok değişkenli regresyon analizleri uygulanmıştır.

Bulgular: Düzeltilmemiş analizlerde, sentetik oksitosin uygulanan grupta fundal bası, plasental retansiyon ve epizyotomi oranları anlamlı düzeyde daha yüksek bulunmuştur ($p<0,05$). Bu gruptaki kadınların STAI skorları ($51,43\pm3,39$ vs. $50,11\pm3,54$, $p=0,040$) ve yenidoğan stres düzeyleri ($p=0,002$) anlamlı derecede yüksek saptanmıştır. Çok değişkenli lojistik regresyon analizinde, olası karıştırıcı faktörler kontrol edildikten sonra sentetik oksitosin uygulamasının epizyotomi (OR=2,04, 95% CI: 1,02–4,00, $p=0,042$) ve plasental retansiyon (OR=7,14, 95% CI: 1,49–33,33, $p=0,014$) ile anlamlı ilişkisi devam etmiştir. Ancak, maternal kaygı ($p=0,077$) ve yenidoğan stresi ($p=0,052$) için kurulan çok değişkenli doğrusal regresyon modelleri genel olarak istatistiksel anlamlılığa ulaşamamıştır; bu durum ilgili değişkenlerin oksitosin uygulamasıyla bağımsız bir ilişki göstermediğine işaret etmektedir.

Sonuç: Çalışma bulguları, sentetik oksitosin uygulamasının epizyotomi ve plasental retansiyon gibi belirli doğuma müdahale oranlarındaki artış ile ilişkili olabileceğini göstermektedir. Ancak genel model sınırlılıkları nedeniyle, sentetik oksitosinin maternal kaygı ve yenidoğan stresi üzerindeki bağımsız ilişkilerine dair bulgular ihtiyatla yorumlanmalıdır. Doğum yönetiminde gereksiz tıbbi müdahalelerden kaçınılması ve bireyselleştirilmiş, kanıta dayalı yaklaşımların benimsenmesi önerilmektedir.

Anahtar Sözcükler: Sentetik oksitosin, doğum indüksiyonu, maternal anksiyete, neonatal stres, doğum müdahaleleri, ebelik.

Introduction

Labor is a physiological process that can occur spontaneously, or it can occur in cases where intervention is required. One of these interventions is the application of induction in labor^{1,2}. Induction in labor is the rupture of the amniotic membrane by stimulating it with mechanical or pharmacological agents in cases where labor does not start spontaneously^{3,4}. Clinically, induction can be applied in cases where cervical ripening is appropriate, signs of labor onset are seen, and there are no contraindications for the mother or baby. In this context, one of the most commonly used agents for initiating labor is synthetic oxytocin^{5,6}.

While the rate of labor induction application varies between 20% and 30% globally, it is observed that this rate is quite high in Türkiye. Oxytocin application rates have been reported as 60-96%, amniotomy rates as 67-78%, and vaginal prostaglandin application rates as 12.6%⁷. In births in which synthetic oxytocin is administered, higher complication rates are encountered compared to spontaneous births. Hyperstimulation, cesarean section, hypotension, antidiuretic effect, neonatal hyperbilirubinemia, uterine

rupture, and fetal distress are among these complications⁸. These complications not only pose physiological risks but also increase anxiety about the labor process in pregnant women.

The labor process is not only a physiological but also a psychological experience for women. A large portion of women are afraid of birth and may experience intense anxiety due to a lack of sufficient information about the nature of birth or due to negative environmental effects^{9,10}. Factors such as the thought that the baby may be harmed during birth, physical pain, loss of control, and a sense of uncertainty increase the level of anxiety in women^{11,12}. This psychological state can negatively affect the course of labor; it can lead to a prolongation of labor, increased pain, and even an increase in the need for intervention. Increased maternal anxiety can cause complications such as fetal stress, bleeding, rapid or prolonged labor¹⁰.

Studies show that state anxiety levels are higher in women who undergo synthetic oxytocin induction during labor compared to those who give birth spontaneously¹. These findings reveal that not only the physiological but also the psychological effects of oxytocin administration should be carefully evaluated.

In our health system, midwives usually apply synthetic oxytocin during labor under a physician's order. It is known that synthetic oxytocin application is quite common in Türkiye⁹. However, before induction, midwives should evaluate the Bishop score, inform the pregnant woman, obtain consent, and provide psychological relief. It is recommended that the fetal heart rate be regularly monitored during the application, the dose be reduced or stopped in case of abnormalities, the pregnant woman be placed in the left lateral position, oxygen be administered, and intravenous fluid support be provided^{7,9,13}.

Induction is an important issue as it affects maternal-fetal mortality and morbidity rates. However, it is known and observed that induction is widely used in our country⁹. On the other hand, when the literature on this subject is examined, limited studies were found, especially limited studies were conducted in the national literature. In these studies, the effect of the labor process on the situation of cesarean delivery, mother-baby bonding, and postpartum anxiety levels were examined⁷.

In this context, the objective of this study was to examine the associations between synthetic oxytocin administration during labor and birth intervention rates, maternal anxiety levels, and newborn stress levels. By comparing women who received synthetic oxytocin with women who experienced natural labor, it was aimed to examine both the physiological and psychological consequences of this medical intervention in a multifaceted manner and to present evidence-based data on the labor process with the findings obtained.

Material and Methods

Research Design

This study was conducted as a single-center, cross-sectional observational study in a public hospital in southern Türkiye between February and June 2025. The study investigated the associations between synthetic oxytocin administration during labor and birth intervention rates, maternal anxiety, and newborn stress levels. Two groups of laborers who received and did not receive synthetic oxytocin were compared.

Population and Sample of the Research

The population of the study was formed in the postpartum ward of Kahramanmaraş Necip Fazıl City Hospital, Maternity and Children's Hospital. The sample size was recalculated using G*Power version 3.1.9.7 for the comparison of two independent group means¹⁴. Based on a two-tailed independent-samples t-test, a moderate effect size (Cohen's $d=0.43$), a type I error rate of 5% ($\alpha=0.05$), and 95% statistical power ($1-\beta=0.95$), the minimum required total sample size was calculated as approximately 288 participants. To account for possible missing or incomplete data, the target sample size was increased, and the study was completed with 300 postpartum women. In the study hospital, the decision to administer synthetic oxytocin was made by the attending obstetrician based on clinical indications such as slow labor progression or inadequate uterine contractions. Following the physician's decision, synthetic oxytocin was administered according to the hospital's standard low-dose oxytocin protocol. The oxytocin solution was prepared as 10 U diluted in 1000 mL of saline. The infusion was initiated at 12 mL/hour and increased by 12 mL/hour every 15 minutes until adequate uterine contractions (3–4 contractions lasting at least 40 seconds within 10 minutes) were achieved. The maximum infusion rate was limited to 48 mL/hour, corresponding to approximately 10 mIU/min. The researchers did not interfere with clinical decision-making and only observed routine clinical practices.

Inclusion Criteria:

- ✓ Being between 18 and 40 years old,
- ✓ Having had a singleton pregnancy,
- ✓ Having given birth at term (37–42 weeks of gestation),
- ✓ Having had a live birth without fetal anomalies,
- ✓ Those in the synthetic oxytocin group were only given synthetic oxytocin during labor,
- ✓ Those who received synthetic oxytocin induction (Synthetic oxytocin group),
- ✓ Those who did not receive synthetic oxytocin induction (Natural oxytocin group).

Exclusion Criteria:

- ✓ Those with a history of medical or obstetric complications (placenta previa, preeclampsia, premature rupture of membranes, oligohydramnios, malpresentation, intrauterine growth retardation, intrauterine dead fetus, macrosomic babies, etc.),
- ✓ Those with a history of psychiatric diagnosis.

Data Collection Tools

Personal Information Form: The Personal Information Form, which was created as a result of the researcher's literature review, consists of questions that determine some characteristics of women (such as age, education, employment) and obstetric history (such as gestational week, number of pregnancies, number of births^{7,15,16}).

Labor Observation Form: This form was prepared based on literature to determine the characteristics of the process by observing the stages of labor by the researcher¹⁷. The form includes a total of 15 questions about the first, second, and third stages of labor.

State Anxiety Inventory (SAI): Developed by Spielberger et al. (1970), it was adapted into Turkish by Öner and Le Compte¹⁸(1983). The State Anxiety Inventory is about describing how a person feels at a certain moment and under certain conditions and the intensity of their feelings at that moment when reading the items of the inventory. The inventory consists of 20 items, and 10 items are reverse scored (items 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20). The lowest total score to be obtained from the inventory is 20, and the highest is 80. As the total score increases, it shows that the anxiety level increases. The reliability coefficients determined by alpha correlations in the adaptation of the State Anxiety Inventory to Turkish were found to be between 0.83 and 0.92¹⁸.

Newborn Stress Scale: The newborn stress scale developed by Ceylan and Bolışık consists of a total of 24 items on a 3-point Likert scale. The scale items include 8 subgroups, including facial expression, body color, respiration, activity level, comfortability, muscle tone, extremities, and posture, and each subgroup is evaluated between 0 and 2 points in the scoring. The minimum score is 0, and the maximum score is 16 points. As the score increases, the baby's stress level increases simultaneously¹⁹.

Data Collection Process

Data were collected through face-to-face interviews starting with admission to the delivery room, during labor pains and delivery, and within the first 24 hours following delivery¹⁶. The State Anxiety Inventory was administered to mothers within the first 6 hours after delivery. The 1-minute and 5-minute APGAR scores were assessed immediately after birth by the neonatal clinical team and obtained directly from the original delivery records. The scores were recorded using the standard 0–10 APGAR scoring system, and no mathematical conversion or rescaling was performed. Newborn stress symptoms were assessed based on clinical observation within the first 30 minutes

after delivery. Throughout the data collection process, all observations and scale applications were carried out by the same trained health professional. This approach was preferred to increase measurement reliability.

Ethical Statement

In order to conduct the study, ethical approval was obtained from Inonu University's Non-Interventional Research Ethics Committee (Decision number: 2025/7112; date: 04.02.2025). In addition, before filling out the data collection forms, necessary explanations were given to the participants in order to protect their rights, and their consent was obtained with the "Informed Consent Form".

Statistical Analysis

The data obtained from the study were analyzed using SPSS 26.0 for Windows software (SPSS Inc., Chicago, IL, USA). Descriptive statistics of the participants are presented as mean $\pm$ standard deviation (Mean $\pm$ SD), number (n), and percentage (%).

In comparing demographic and labor characteristics between groups, appropriate tests were used according to the type and distribution of the variables. The Kolmogorov-Smirnov test was used to evaluate the suitability of continuous variables for normal distribution; the independent samples t-test was used for pairwise group comparisons of variables with normal distribution; and the Mann-Whitney U test was used for variables without normal distribution. Group comparisons for categorical variables were performed using the chi-square test (χ^2). Statistical significance was determined as $p < 0.05$. In addition, multivariable logistic regression analyses were performed to examine the independent association between synthetic oxytocin administration and obstetric interventions. Multiple linear regression analyses were conducted to evaluate the associations between synthetic oxytocin administration and maternal anxiety and newborn stress levels. These models were adjusted for potential confounding variables, including maternal age, education level, income status, parity, pregnancy intention, gestational age, cervical dilatation, and oxygen requirement. Adjusted odds ratios (OR), standardized regression coefficients (β), and 95% confidence intervals (CI) were reported.

Results

The comparison of the sociodemographic characteristics of the participants according to their synthetic oxytocin intake is presented in Table 1. The mean age of the participants who gave birth with natural oxytocin was determined to be 27.35 ± 5.80 , and the mean age of those who received synthetic oxytocin was determined to be 27.24 ± 6.07 . It was determined that there was a statistically significant difference between the groups in terms of educational level and parity of the participants who gave birth naturally and with synthetic oxytocin ($p < 0.05$). However, it was determined that there was no statistically significant difference between the groups in terms of age, employment, income level, and desired pregnancy variables ($p > 0.05$; Table 1).

Table 1. Comparison of the sociodemographic characteristics of participants according to oxytocin administration (n=300).

Characteristics	Natural oxytocin (n=103)		Synthetic oxytocin (n=197)		Test and p values
	n	%	n	%	
Age (years) (Mean±SD)	27.35±5.80		27.24±6.07		t=-0.159 p=0.874
Educational level					$\chi^2=30.889$ p<0.001
Middle school or lower	61	59.2	56	28.4	
High school	36	35.0	96	48.7	
University or higher	6	5.8	45	22.8	
Employment					$\chi^2=0.513$ p=0.474
Employed	19	18.4	30	15.2	
Unemployed	84	81.6	167	84.8	
Income level					$\chi^2=0.729$ p=0.695
Good	10	9.7	15	7.6	
Moderate	71	68.9	133	67.5	
Low	22	21.4	49	24.9	
Having a desired pregnancy					$\chi^2=1.915$ p=0.166
Present	91	88.3	162	82.2	
Absent	12	11.7	35	17.8	
Parity					$\chi^2=5.709$ p=0.017
Multiparous	76	70.9	118	59.9	
Primiparous	27	29.1	79	40.1	

χ^2 : Chi-square test

Comparison of the participants' labor characteristics according to oxytocin administration is presented in Table 2. No significant difference was found between the groups receiving natural and synthetic oxytocin in terms of gestational age, cervical dilatation, amniotic fluid characteristics, oxygen requirement, and mode of delivery ($p>0.05$). On the other hand, statistically significant differences were found between the groups in terms of fundal pressure application, placental retention requirement, and episiotomy requirement ($p<0.05$). It was observed that these practices were used more frequently in participants receiving synthetic oxytocin (Table 2).

Table 2. Comparison of the participants' labor characteristics according to oxytocin administration (n=300).

Characteristics	Natural oxytocin (n=103)		Synthetic oxytocin (n=197)		Test and p values
	n	%	n	%	
Gestational age (weeks) (Mean±SD)	39.36±1.55		39.69±1.49		t=-0.328 p=0.743
Cervical dilatation					
None	55	53.4	111	56.3	$\chi^2=0.400$ p=0.819
1-4 cm	45	43.7	82	41.6	
≥5 cm	3	2.9	4	2.0	
Amniotic fluid					
Clear	87	84.5	166	84.3	$\chi^2=0.002$ p=0.964
Meconium	16	15.5	31	15.7	
Oxygen requirement					
Present	20	19.4	35	17.8	$\chi^2=0.123$ p=0.726
Absent	83	80.6	162	82.2	
Application of fundal pressure					
Present	22	21.4	64	32.5	$\chi^2=4.096$ p=0.043
Present	81	78.6	133	67.5	
Absent					
Need for placental retention					
Present	2	1.9	17	8.6	$\chi^2=5.099$ p=0.024
Present	101	98.1	180	91.4	
Absent					
Episiotomy requirement					
Present	23	22.3	66	33.5	$\chi^2=4.046$ p=0.044
Absent	80	77.7	131	66.5	
Mode of delivery					
Vaginal	98	91.5	189	95.9	$\chi^2=0.103$ p=0.749
Caesarean	5	4.9	8	4.1	

x²: Chi-square test

The comparison of maternal anxiety and newborn outcomes according to natural and synthetic oxytocin applications is presented in Table 3. According to maternal assessment, the SAI mean score of women who were administered synthetic oxytocin was found to be statistically significantly higher than women who were administered natural oxytocin (mean difference = 1.32, 95% CI: 0.48–2.16; Cohen's d = 0.38; p=0.040). This finding suggests that synthetic oxytocin administration was associated with higher maternal anxiety levels.

According to neonatal assessment, the mean 1-minute APGAR score was significantly higher in the natural oxytocin group than in the synthetic oxytocin group (mean difference = -0.18 , 95% CI: -0.28 to -0.08 ; Cohen's $d = -0.47$; $p=0.001$). However, the mean 5-minute APGAR scores increased to 8.42 ± 1.52 and 8.52 ± 1.20 , respectively, and no statistically significant difference was observed between the groups (mean difference = -0.30 , 95% CI: -0.64 to 0.04 ; Cohen's $d = -0.23$; $p=0.087$). In addition, the NSS mean score was significantly higher in the synthetic oxytocin group (mean difference = 0.28 , 95% CI: 0.08 – 0.48 ; Cohen's $d = 0.25$; $p=0.002$). These findings indicate differences between the groups in immediate neonatal outcomes; however, no significant difference was observed in the 5-minute APGAR assessment (Table 3).

Table 3. Comparison of the maternal anxiety and newborn outcomes according to natural and synthetic oxytocin administration (n = 300).

Variables	Natural oxytocin (n=103)	Synthetic oxytocin (n=197)	Mean Difference (95% CI)		Cohen's d	Test*	p value
	mean±SD	mean±SD					
SAI	50.11±3.54	51.43±3.39	1.32	(0.48–2.16)	0.38	2.059	p=0.040
APGAR 1 st min.	6.10±0.46	5.92±0.34	−0.18	(−0.28−−0.08)	−0.47	3.719	p=0.001
APGAR 5 th min.	8.42±1.52	8.52±1.20	−0.30	(−0.64−0.04)	−0.23	1.850	p=0.087
NSS	0.04±0.21	0.32±1.37	0.28	(0.08−0.48)	0.25	−3.137	p=0.002

SD: Standard Deviation, *: Independent samples t-test, NSS variable was analyzed using the Mann–Whitney U test due to skewed distribution, SAI: State Anxiety Inventory NSS: Newborn Stress Scale, Mean difference calculated as synthetic oxytocin minus natural oxytocin. Cohen's d values interpreted as small (0.2), medium (0.5), and large (0.8) effect sizes.

Table 4. Multivariable logistic regression analysis of the association between synthetic oxytocin administration and obstetric outcomes.

Variable	Episiotomy OR (95% CI)	p	Fundal Pressure OR (95% CI)	p	Placental Retention OR (95% CI)	p
Oxytocin	2.04 (1.02–4.00)	0.042*	1.79 (0.88–3.70)	0.106	7.14 (1.49–33.33)	0.014*
Age	0.97 (0.91–1.03)	0.306	0.94 (0.88–1.01)	0.068	1.10 (0.99–1.22)	0.075
Education	0.65 (0.42–1.01)	0.056	0.77 (0.49–1.23)	0.272	0.71 (0.33–1.55)	0.394
Income	0.84 (0.53–1.34)	0.461	1.00 (0.61–1.63)	1.000	0.53 (0.23–1.24)	0.144
Parity	0.16 (0.09–0.30)	<0.001*	0.14 (0.08–0.26)	<0.001*	0.55 (0.17–1.77)	0.320

Pregnancy planning	0.62 (0.21–1.83)	0.382	0.51 (0.15–1.79)	0.296	0.44 (0.08–2.31)	0.333
Gestational age	0.94 (0.77–1.16)	0.569	0.94 (0.76–1.16)	0.556	0.88 (0.62–1.23)	0.443
Oxygen requirement	1.68 (0.76–3.72)	0.204	1.15 (0.52–2.53)	0.733	1.16 (0.31–4.34)	0.829
Cervical dilatation	1.01 (0.76–1.35)	0.954	0.90 (0.66–1.23)	0.504	0.42 (0.16–1.12)	0.084

OR: Odds Ratio, CI: Confidence Interval, * $p < 0.05$ statistically significant

All models were adjusted for maternal age, education, income, parity, pregnancy intention, gestational age, cervical dilatation, and oxygen requirement

**Synthetic oxytocin administration was coded as 0 = no synthetic oxytocin administration and 1 = synthetic oxytocin administration. Therefore, OR > 1 indicates higher odds of the outcome among women receiving synthetic oxytocin.

The multivariable logistic regression analyses examining the association between synthetic oxytocin administration and obstetric outcomes are presented in Table 4. After adjusting for maternal age, educational level, income status, parity, pregnancy planning, gestational age, cervical dilatation, and oxygen requirement, a statistically significant association was found between synthetic oxytocin administration and episiotomy (OR=2.04, 95% CI: 1.02–4.00, $p=0.042$). Similarly, a significant association was observed between synthetic oxytocin administration and placental retention (OR = 7.14, 95% CI: 1.49–33.33, $p = 0.014$). However, no statistically significant association was found between synthetic oxytocin administration and fundal pressure application ($p>0.05$). In addition, parity was identified as a significant predictor for both episiotomy and fundal pressure ($p<0.05$). As parity increased, the likelihood of episiotomy decreased (OR=0.16, 95% CI: 0.09–0.30, $p<0.001$). No significant associations were observed between the other covariates and obstetric outcomes ($p>0.05$) (Table 4).

Table 5. Multivariable linear regression analysis of maternal anxiety and newborn stress.

Variable	Maternal Anxiety (β)	95% CI	p	Newborn Stress (β)	95% CI	p
Oxytocin administration	0.170	0.348 – 2.148	0.007	0.142	0.048 – 0.628	0.023
Age	-0.092	-0.127 – 0.019	0.145	0.108	-0.003 – 0.044	0.086
Education	0.025	-0.475 – 0.716	0.691	-0.062	-0.290 – 0.094	0.316
Income	-0.002	-0.671 – 0.645	0.969	0.041	-0.137 – 0.287	0.486

Parity	-0.011	-1.004 – 0.839	0.860	0.074	-0.122 – 0.472	0.247
Gestational age	0.011	-0.259 – 0.311	0.859	-0.014	-0.102 – 0.081	0.824
Cervical dilatation	0.024	-0.309 – 0.460	0.699	-0.094	-0.219 – 0.029	0.134
Oxygen requirement	-0.069	-1.653 – 0.401	0.231	-0.020	-0.390 – 0.272	0.727
Model statistics	Maternal Anxiety Model R ² = 0.047 Adjusted R ² = 0.021 p = 0.077			Newborn Stress Model R ² = 0.051 Adjusted R ² = 0.025 p = 0.052		

β: Standardized regression coefficient, CI: Confidence interval, *p < 0.05 statistically significant

The multivariable linear regression analyses examining the associations between synthetic oxytocin administration and maternal anxiety and newborn stress levels are presented in Table 5. Although the regression coefficient for synthetic oxytocin administration was statistically significant in the maternal anxiety model ($\beta = 0.170$, $p = 0.007$), the overall regression model was not statistically significant (model $p = 0.077$). Similarly, although the regression coefficient for synthetic oxytocin administration reached statistical significance in the newborn stress model ($\beta=0.142$, $p=0.023$), the overall model did not reach statistical significance (model $p=0.052$). No statistically significant associations were observed for the remaining covariates ($p>0.05$). Therefore, these findings should be interpreted with caution and should not be considered evidence of independent associations between synthetic oxytocin administration and maternal anxiety or newborn stress levels (Table 5).

Discussion

This study found that synthetic oxytocin administration during labor was associated with differences in maternal and newborn outcomes. The findings presented that maternal anxiety levels were significantly higher in the group receiving synthetic oxytocin, interventions during labor (fundal compression, episiotomy, placental retention, etc.) occurred more frequently, and newborn stress levels were higher. These results emphasize that not only the physiological but also the psychological consequences of synthetic oxytocin administration should be considered.

When evaluated from a sociodemographic perspective, educational level and parity variables significantly affect synthetic oxytocin administration. The higher rate of synthetic oxytocin administration among women with higher education levels may be related to differences in communication with healthcare professionals or variations in clinical decision-making processes. However, this interpretation should be considered cautiously, as the observational design does not allow causal inference. This situation has

also been emphasized in the literature by Sharan et al.²⁰. However, the fact that variables such as age, employment, income level, and having a desired pregnancy are not significantly related to synthetic oxytocin application suggests that clinical decision processes are more effective in the application of this intervention.

It is frequently emphasized in the literature that labor is a physiological process and that this process should be allowed to proceed as naturally as possible²¹. However, in some cases, medical interventions may be unavoidable. Synthetic oxytocin induction is a method frequently used to initiate and advance labor. However, the findings obtained in our study revealed that this intervention may be accompanied by chain interventions in the labor process and may be associated with higher frequencies of obstetric interventions. Indeed, in our study, fundal pressure, episiotomy, and placental retention rates were found to be significantly higher in the synthetic oxytocin group²²⁻²⁴.

When evaluated in terms of maternal psychological outcomes, postpartum anxiety scores were significantly higher in women who received synthetic oxytocin. However, the multivariable linear regression model was not statistically significant overall; therefore, these findings should be interpreted cautiously and should not be considered evidence of an independent association between synthetic oxytocin administration and maternal anxiety. Factors such as continuous fetal monitoring, restriction of freedom of movement, and decreased sense of control over the birth process can increase women's anxiety levels^{1,21}. Similarly, in previous studies, it was stated that oxytocin administration increased labor pain, contraction intensity, and postpartum fear levels¹⁶. These findings suggest that postpartum anxiety levels may be associated with the overall childbirth experience and obstetric interventions rather than synthetic oxytocin alone.

When evaluated in terms of newborn outcomes, the mean 1-minute APGAR score was significantly higher in the natural oxytocin group than in the synthetic oxytocin group. The 1-minute and 5-minute APGAR scores were rechecked against the original delivery records by the neonatal clinical team. This re-evaluation confirmed that the recorded APGAR scores accurately reflected the original delivery records and had been documented using the standard 0–10 APGAR scoring system, without any mathematical conversion or rescaling. Although the mean 1-minute APGAR scores were relatively low in both groups, the mean 5-minute APGAR scores increased to above 8, indicating rapid early neonatal adaptation. Therefore, a relatively low 1-minute APGAR score alone should not be interpreted as evidence of neonatal asphyxia, particularly in the absence of additional clinical indicators such as cord blood gas analysis or neonatal resuscitation data. In addition, the Neonatal Stress Scale score was significantly higher in the synthetic oxytocin group. These findings should be interpreted cautiously because detailed neonatal clinical parameters, such as cord blood gas analysis and neonatal resuscitation data, were not available in the present study. These findings are also supported by Thangarajah et al. (2016)²⁵, who reported that babies who underwent induction required more medical intervention. On the other hand, some studies, such as Budak et al. (2016)⁵ and Budden et al. (2014)²⁶, reported that synthetic oxytocin had no significant effect on APGAR scores. These contradictory findings indicated that further studies are needed on

the effects of synthetic oxytocin administration on newborn health. Similarly, although newborn stress scores differed significantly between the groups in the unadjusted analyses, the adjusted multivariable regression model was not statistically significant overall. Therefore, these findings should be interpreted cautiously and should not be considered evidence of an independent association between synthetic oxytocin administration and newborn stress levels.

In general, these findings indicated that it is important for both maternal and newborn health to allow birth to occur under physiological conditions as much as possible. Medical interventions should be limited unless necessary, and the natural course of birth should be supported. Careful evaluation of synthetic oxytocin applications in clinical decision processes is crucial in terms of preventing the chain of interventions and possible complications related to labor. These findings suggest a possible association between synthetic oxytocin administration and maternal and neonatal outcomes; however, this relationship may be influenced by underlying clinical and obstetric factors. In addition, detailed clinical parameters such as Bishop score, membrane status, and active or latent labor phase were not systematically recorded in this study. However, cervical dilatation and amniotic fluid characteristics were included in the analysis to partially account for clinical labor conditions. Therefore, the observed differences between groups may partly reflect underlying clinical indications rather than the direct effects of synthetic oxytocin.

Strengths of the Study

This study has several strengths. First, it evaluates synthetic oxytocin administration together with both maternal and neonatal outcomes, providing a comprehensive and interdisciplinary perspective. Second, the study was conducted in a real clinical setting, reflecting routine obstetric practice and increasing the external validity of the findings. Third, the sample size was adequate and supported by power analysis, which strengthens the reliability of the results.

Limitation

These findings should be interpreted considering several limitations. First, the State Anxiety Inventory was administered within the first 6 hours postpartum; therefore, anxiety scores may reflect not only synthetic oxytocin exposure but also labor difficulty, obstetric interventions, pain, fatigue, and early postpartum physiological and emotional conditions. Second, newborn stress was assessed through clinical observation within the first 30 minutes after birth by the same healthcare professional. As the evaluator was not blinded to group allocation, observer bias cannot be ruled out. Third, although multivariable analyses were conducted, the observational design of the study limits causal interpretation. In addition, detailed clinical parameters such as Bishop score, membrane status, and active or latent labor phase were not systematically recorded. Therefore, the observed differences may partly reflect underlying clinical conditions rather than the direct effects of synthetic oxytocin.

Conclusion

This study found that synthetic oxytocin administration during labor was associated with higher frequencies of obstetric interventions. In line with these findings, it is recommended that healthcare professionals, especially midwives, be more careful in their decisions regarding oxytocin administration and adopt an individualized approach. Avoiding unnecessary interventions and adopting an individualized, evidence-based approach may contribute to a more positive birth experience and potentially better maternal and neonatal outcomes. This study emphasized once again that synthetic oxytocin applications are not limited to physiological outcomes; moreover, birth should be considered as a holistic experience.

Conflict of Interest: There is no conflict of interest.

Financial Support: The authors declare that they received no financial support for this study.

Authorship Contribution: HGÖ, ESB, MK; idea/concept, design, supervision, analysis, writing, critical review. HGÖ, ESB, MK; interpretation, writing, critical review. HGÖ, ESB; sources, data collection, literature review.

REFERENCES

1. Göçen NN, Amanak K. Efectele inducției travaliului asupra legăturii postpartum mamă-copil și a nivelului de anxietate [The effects of labor induction on postpartum mother-infant bonding and anxiety levels]. *JBM*. 2022;17–25. doi: 10.31926/jmb.2022.1.1.
2. Romano AM, Lothian JA. Promoting, protecting, and supporting normal birth: a look at the evidence. *Journal of Obstetric, Gynecologic & Neonatal Nursing*. 2008;37(1):94–105.
3. Erickson EN, Bailey JM, Colo SD, Carlson NS, Tilden EL. Induction of labor or expectant management? Birth outcomes for nulliparous individuals choosing midwifery care. *Birth*. 2021;48(4):501–513. doi: 10.1111/birt.12560.
4. Mc Carthy FP, Kenny LC. Induction of labour. *Obstetrics, Gynaecology & Reproductive Medicine*. 2014;24(1):9–15. doi: 10.1016/j.ogrm.2013.11.004.
5. Budak MŞ, Kaya C, Akgöl S, et al. Labor Induction with prostaglandin e2- experience of a maternity and children's disease hospital. *The Journal of Gynecology - Obstetrics and Neonatology*. 2013;13(2):61–64.

6. Demirel G, Çelik Bilgiç D. Doğal doğuma müdahale: sentetik oksitosin kullanımı. düzeylerinin incelenmesi. *STED / Sürekli Tıp Eğitimi Dergisi*. 2013;22(4):157–162.
7. Bal Şaraldi H, Ekin P, Karaçam Z. Doğumda indüksiyon uygulanma durumunun acil sezaryen doğuma etkisi. *Karya Journal of Health Science*. 2023;4(3):192–198.
8. Clark SL, Miller DD, Belfort MA, Dildy GA, Frye DK, Meyers JA. Neonatal and maternal outcomes associated with elective term delivery. *American Journal of Obstetrics and Gynecology*. 2009;200(2):156.e1-156.e4. doi: 10.1016/j.ajog.2008.08.068.
9. Bay F, Özbolat Ü. Doğum indüksiyonu: maternal, fetal-neonatal etkileri, ebeğin rolü. *KTO Karatay Üniversitesi Sağlık Bilimleri Dergisi*. 2020;1(1):4–14.
10. Üst ZD, Pasinlioğlu T, Özkan H. Doğum eyleminde gebelerin anksiyete. *Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi*. 2013;16(2):110–116.
11. Çalışkan E. Doğuma Hazırlık Eğitiminin Perinatal Anksiyete Düzeyi, Doğum Korkusu ve Bağlanmaya Etkisi. [yüksek lisans tezi], İstanbul Medipol Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul, 2019.
12. Bayrampour H, Ali E, McNeil DA, Benzies K, MacQueen G, Tough S. Pregnancy-related anxiety: a concept analysis. *International Journal of Nursing Studies*. 2016;55:115–130.
13. Simpson KR, James DC. Efficacy of intrauterine resuscitation techniques in improving fetal oxygen status during labor. *Obstetrics & Gynecology*. 2005;105(6):1362–1368.
14. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*. 2007;39(2):175–191. doi: 10.3758/BF03193146.
15. Öztürk Dönmez R, Fidan G. The use of the intervention wheel in pregnancy monitoring during the pandemic. *Ege University Faculty of Nursing Journal*. 2024;40(2):321–327.
16. İsbir GG, Topçu B. The effects of intrapartum oxytocin induction on labor pain and fear of labor. *Hemşirelik Eğitim ve Araştırma Dergisi*. 2018;15(2):94–98.
17. Başgöl Ş, Beji Kızılkaya N. Kontinans hemşirelerinin gelişen rollerinin uluslararası düzeyde irdelenmesi. *Florence Nightingale Hemşirelik Dergisi*. 2015;23(3):224–230.

18. Öner N, Le Compte W. *Intermittent State/Continuous Anxiety Inventory Handbook*. Istanbul: Boğaziçi University Press; 1985.
19. Ceylan SS, Bolışık B. Yenidoğan stres ölçeği'nin psikometrik özelliklerinin incelenmesi. *Acıbadem Üniversitesi Sağlık Bilimleri Dergisi*. 2017;2:97–103.
20. Sharan M, Strobino D, Ahmed S. Intrapartum oxytocin use for labor acceleration in rural India. *International Journal of Gynecology & Obstetrics*. 2005;90(3):251–257.
21. Buckley S, Uvnäs-Moberg K, Pajalic Z, et al. Maternal and newborn plasma oxytocin levels in response to maternal synthetic oxytocin administration during labour, birth and postpartum – a systematic review with implications for the function of the oxytocinergic system. *BMC Pregnancy Childbirth*. 2023;23(1):137.
22. Şentürk Erenel A, Çiçek S. Doğum şeklinin anne ve yenidoğan sağlığına etkisi. *Süleyman Demirel Üniversitesi Sağlık Bilimleri Dergisi*. 2018;9(2):123–129.
23. Girgin Ş, Tezcan H, Hamlacı Başkaya Y. The effect of medicalisation in childbirth on childbirth satisfaction and postpartum comfort level. *KTO Karatay Üniversitesi Sağlık Bilimleri Dergisi*. 2024;5(2):108–120. doi: 10.59244/ktokusbd.1453673.
24. Şahin M, Erbil N. Birth and medicalization. *Ordu University J Nurs Stud*. 2019;2(2):120-130.
25. Thangarajah F, Scheufen P, Kirn V, Mallmann P. Induction of labour in late and postterm pregnancies and its impact on maternal and neonatal outcome. *Geburtshilfe Frauenheilkd*. 2016;76(07):793–798. doi: 10.1055/s-0042-107672.
26. Budden A, Chen LJ, Henry A. High-dose versus low-dose oxytocin infusion regimens for induction of labour at term. *Cochrane Database of Systematic Reviews*. 2014;10:CD009701. doi: 10.1002/14651858.CD009701.pub2/full

The Use of Physician Rating Sites and Their Impact on Physician Preference

Aslı METİN*

Abstract

Aim: This study aims to determine the awareness of individuals regarding physician review websites and to examine the effect of online physician reviews on patient preferences.

Method: The study was conducted with 422 participants aged 18 and over. Data were collected using the “Online Physician Reviews and Patient Preferences Scale” developed by the researcher. Exploratory factor analysis confirmed a unidimensional structure (KMO=0.805; Bartlett test $\chi^2(15)=335.73$, $p<0.001$) and the scale showed acceptable reliability ($\alpha=0.741$). Descriptive statistics, independent samples t-tests, one-way ANOVA and regression analyses were used in the analysis of the data.

Results: The findings showed that 52.8% of the participants visited physician review websites and Doktor Takvimi (a Turkish physician rating website) was the most frequently used platform. Participants stated that they used these platforms more to read physician reviews than to create content. Both positive and negative reviews were found to influence patient preferences. While no significant difference was observed in terms of gender, age, marital status, or income ($p>.05$), education level was found to have a significant effect ($p<.05$). Post hoc analyses revealed that individuals with postgraduate education were less influenced by online physician reviews than those with lower education levels. Regression analysis showed that perceived trustworthiness of online reviews significantly predicted the effects on patient preferences ($\beta=0.468$, $p<.001$) and explained a significant portion of the variance ($R^2=0.437$).

Conclusion: The results suggest that the influence of physician review websites on patient preferences is primarily determined by perceived trustworthiness rather than usage. Although awareness of these platforms is high, users tend to remain passive. The findings highlight the importance of trust in shaping the impact of digital health information and suggest that higher education levels may reduce reliance on such platforms.

Keywords: Physician rating websites, patient preference, perceived credibility, online reviews.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 03.10.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1796458>

* Asst. Prof. Dr., Isparta University of Applied Sciences, Uluborlu Selahattin Karasoy Vocational School, Department of Health Care Services, Isparta, Türkiye. E-mail: aslimetin@isparta.edu.tr  <https://orcid.org/0000-0002-6967-1772>.

ETHICAL STATEMENT: The study was conducted between August 2024 and October 2024. Necessary permissions were obtained from the Scientific Research and Publication Ethics Committee of Isparta University of Applied Sciences (Date: April 24, 2024, Issue No: 191). Participants were provided with a document stating that participation in the study was voluntary and that the information collected would be used solely for scientific purposes. A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant.

Hekim Derecelendirme Sitelerinin Kullanımı ve Hekim Tercihine Etkisi

Amaç: Bu çalışmanın amacı, bireylerin hekim derecelendirme sitelerine yönelik farkındalıklarını belirlemek ve çevrimiçi hekim yorumlarının hasta tercihleri üzerindeki etkisini incelemektir.

Yöntem: Çalışma, 18 yaş ve üzeri 422 katılımcı ile gerçekleştirilmiştir. Veri toplama aracı olarak araştırmacı tarafından geliştirilen “Online Hekim Derecelendirmeleri ve Hasta Tercihleri Ölçeği” kullanılmıştır. Açıklayıcı faktör analizi sonucunda ölçeğin tek boyutlu bir yapıya sahip olduğu belirlenmiştir (KMO=0,805; Bartlett testi $\chi^2(15) = 335,73$, $p < ,001$). Ölçeğin güvenilirliği Cronbach’s Alpha katsayısı ile değerlendirilmiş ve kabul edilebilir düzeyde bulunmuştur ($\alpha = 0,741$). Verilerin analizinde tanımlayıcı istatistikler, bağımsız örneklem t-testi, tek yönlü varyans analizi (ANOVA) ve regresyon analizleri kullanılmıştır.

Bulgular: Bulgular, katılımcıların %52,8’inin hekim derecelendirme sitelerini en az bir kez ziyaret ettiğini ve en sık kullanılan platformun Doktor Takvimi olduğunu göstermektedir. Katılımcıların bu siteleri çoğunlukla hekim yorumlarını okumak amacıyla kullandıkları ve aktif katkı düzeylerinin düşük olduğu belirlenmiştir. Hem olumlu hem de olumsuz yorumların hasta tercihlerini etkilediği görülmüştür. Demografik değişkenler açısından yapılan analizlerde cinsiyet, yaş, medeni durum ve gelir değişkenlerine göre anlamlı fark bulunmazken ($p > ,05$), eğitim düzeyi açısından anlamlı fark tespit edilmiştir ($p < ,05$). Post-hoc analizler, lisansüstü eğitim düzeyine sahip bireylerin çevrimiçi hekim yorumlarından daha az etkilendiğini göstermiştir. Regresyon analizi sonuçlarına göre, çevrimiçi yorumlara duyulan güvenin hasta tercihleri üzerindeki etkiyi anlamlı ve güçlü biçimde yordadığı belirlenmiştir ($\beta = 0,468$, $p < ,001$) ve model toplam varyansın önemli bir kısmını açıklamaktadır ($R^2 = 0,437$).

Sonuç: Araştırma bulguları, hekim derecelendirme sitelerinin hasta tercihleri üzerindeki etkisinin yalnızca kullanım sıklığına bağlı olmadığını, esas olarak bu platformlara duyulan güven tarafından belirlendiğini göstermektedir. Bu sitelere yönelik farkındalık yüksek olmasına rağmen kullanıcıların çoğunlukla pasif olduğu görülmektedir. Bulgular, dijital sağlık bilgilerinin etkisinin anlaşılmasında güvenin merkezi bir rol oynadığını ve eğitim düzeyi arttıkça bu etkinin azaldığını ortaya koymaktadır.

Anahtar Sözcükler: Hekim derecelendirme siteleri, hasta tercihi, güven, çevrimiçi yorumlar.

Introduction

The internet and technological advancements have become an indispensable part of social life¹. Individuals have begun using the internet to find quick solutions to their problems and questions. Healthcare access, typically a supply-driven system, has also undergone a similar transformation. Health information-seeking behavior has moved beyond traditional methods and been influenced by technological advancements. This shift has enabled individuals to participate more actively in decision-making processes regarding their health.

The evolution of health information-seeking channels allows individuals to examine and evaluate options and choose among alternatives^{2,3}. Previously, individuals generally accessed health information through traditional methods such as family and friends. With the introduction of the internet and networking technologies, however, the limited range of stakeholders accessing information has expanded⁴. Technology allows individuals to exchange information regardless of time and space. Patients seeking information during the healthcare process have increasingly turned to the internet for guidance. They not only learn about hospitals and treatment methods but also search for

physicians. This shift places greater importance on perceived quality in treatment and physician preferences. Patients make decisions based on their own criteria for selecting a good physician. They often prefer physicians with strong clinical and communication skills. As a result, health information seeking has merged with social influence on the internet, a major source of informal information. Like other goods and services, customer reviews and guidance now significantly influence consumer behavior in healthcare, thanks to widespread internet use. Patients who turn to the internet to share their clinical experiences and compare physicians or medical treatments can be influenced by individuals they've never met. Digitally evaluating service experiences allows users to review and comment on specific physicians. In this process, physician rating websites which are viewed as representative of customer-centric service delivery along with the information they provide, have begun to play an increasingly important role in the lives of healthcare consumers and have attracted the attention of medical practitioners⁵.

Physician-rating websites can be described as a "new source" of information about the quality of care from the patient's perspective⁶. These platforms allow patients to evaluate their experiences with physicians on a web-based platform. Through patient feedback, these experiences help others gain insight into the physician and the care process⁷. Patient reviews published on crowdsourcing platforms are having an increasing impact on other patients' medical decision-making processes^{8,9}. These websites, which primarily provide physicians' addresses, office hours, and other information, also include patient experiences. By allowing patients to publicly share their perceptions of physician service quality, these platforms not only guide other patients but also provide valuable feedback for physicians^{10,11}.

This study primarily aims to examine the awareness and use of physician rating websites and to evaluate the influence of online physician reviews on physician preference. Additionally, a short scale was developed and psychometrically evaluated to measure the perceived impact of online physician reviews. The following questions were addressed in this study:

- 1- What is the level of awareness among individuals regarding physician rating websites?
- 2- Do physician rating websites influence individuals' healthcare purchasing behaviors?

Material and Methods

Participants

This descriptive, cross-sectional study aims to examine the use and awareness of physician rating websites among individuals over the age of 18 and to reveal the impact of these websites on healthcare decision-making. The target population of the study consists of individuals over the age of 18 residing in Türkiye. The sample was determined using a convenience sampling method, and participants were recruited on a voluntary basis¹². Although a minimum sample size of 385 was suggested based on a 5% margin of

error and a 95% confidence level, a total of 422 individuals participated in the study. No limitations were imposed regarding city or occupation when selecting the sample.

Methods

The survey form used in the study was developed by the researcher based on a comprehensive literature review. The survey consists of three sections. The first section includes questions related to gender, age, marital status, education level, income level and the presence of chronic diseases to determine the sociodemographic characteristics of the participants. The second section includes questions aimed at evaluating the participants' awareness of and purposes for using online physician review platforms. The third section focuses on the participants' perceptions of the health information and physician preferences offered on these platforms. This section was developed based on relevant studies in the literature. In addition, the researcher developed a six-item "Online Physician Reviews and Patient Preferences Scale" to measure the perceived impact of online physician reviews on patient preferences. The scale was designed as a five-point Likert-type measure. Exploratory factor analysis showed that the scale has a unidimensional structure. The Kaiser-Meyer-Olkin (KMO) value was found to be 0.805 and Bartlett's sphericity test was statistically significant ($p < 0.001$), confirming the suitability of the data for factor analysis. The single-factor structure explained 35.37% of the total variance.

The internal consistency of the scale was found to be acceptable with a Cronbach's Alpha coefficient of 0.74¹³. Although the explained variance is low (35.37%), it exceeds the acceptable threshold for one-dimensional structures, which is generally considered to be 30% or higher in the social sciences¹⁴. This indicates that the scale demonstrates an acceptable level of construct representation

Ethical Statement

The study was conducted between August 2024 and October 2024. Necessary permissions were obtained from the Scientific Research and Publication Ethics Committee of Isparta University of Applied Sciences (Date: April 24, 2024, Issue No: 191). Participants were provided with a document stating that participation in the study was voluntary and that the information collected would be used solely for scientific purposes.

Statistical Analysis

IBM SPSS Statistics 27 was used to analyze the data obtained in the study. First, descriptive statistics such as frequency, mean, and standard deviation were calculated to summarize the sociodemographic characteristics of the participants and their responses to the survey items.

The "Scale on the Impact of Online Physician Ratings on Patient Preferences" was initially developed with an item pool of seven statements. A pilot study was conducted

with 50 participants to assess clarity and comprehensibility. Based on participant feedback and preliminary analysis, one item was removed due to insufficient clarity, resulting in a final six-item scale. The main data collection was then carried out with 422 participants.

To assess the construct validity of the scale, an exploratory factor analysis (EFA) was conducted. The Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s test of sphericity were used to evaluate sampling adequacy. Internal consistency reliability was assessed using Cronbach’s Alpha coefficient.

Prior to inferential analyses, the distribution of the data was examined using skewness and kurtosis values. The results indicated that the data were approximately normally distributed; therefore, parametric tests were employed. Independent samples t-tests were used for comparisons between two groups and one-way ANOVA was used for comparisons among three or more groups. Post-hoc comparisons were conducted using the Tukey test.

The regression model was constructed based on previous studies highlighting the role of perceived credibility in shaping how individuals use online health information. Perceived credibility was the primary predictor variable, while website usage, education level and gender were control variables. The model aims to explain the impact of perceived credibility on patient behaviour regarding physician preference.

Linear regression analyses were conducted to examine the predictive effect of perceived credibility of online physician ratings on patient preferences. Both simple and multiple regression models were constructed to evaluate the role of demographic variables alongside the main predictor. The Breusch–Pagan test indicated no evidence of heteroskedasticity ($p > 0.05$). Heteroskedasticity-robust standard errors were also applied and the results remained consistent. These findings indicate that the regression model is statistically reliable and robust.

Results

The research was conducted with 422 participants and demographic data and frequencies of the participants are given in Table 1.

Table 1. Descriptive findings regarding the participants

		n	%
Gender	Female	257	61.3
	Male	162	38.4
Age	18-24	127	30.4
	25-34	135	32.3
	35-45	98	23.4
	≥46	58	13.9

Education	Primary School	48	11.7
	High School	96	23.4
	Associate Degree	73	17.8
	License	155	37.7
	Graduate	39	9.5
Marital status	Married	226	53.5
	Single	192	45.5
Income status*	≤ 17000 TL	139	38.8
	17001- 30000 TL	83	23.2
	30001- 50000 TL	104	29.1
	≥50001 TL	32	8.9
Number of visits to a physician in the last year *	1 - 5	262	62.1
	6 - 10	83	19.7
	≥11	36	8.5
Do you have a chronic disease?	Yes	73	17.3
	No	349	82.7
Total		422	100

* The number of participants who answered the question is not 100%

A total of 422 participants were included in the study. The study comprised 61.3% female and 38.4% male participants. The age distribution showed that 30.4% were between the ages of 18–24, 32.3% were between the ages of 25–34, 23.4% were between the ages of 35–45, and 13.9% were 46 years of age or older. In terms of educational level, 11.7% of the participants had a primary school education, 23.4% had a high school education, 17.8% had an associate's degree, 37.7% had a bachelor's degree and 9.5% had a postgraduate degree. Regarding marital status, 53.5% of the participants were married and 45.5% were single. According to the income status variable, 38.8% of the participants had an income of 17.000 TL or less, 23.2% had an income between 17.001 and 30.000 TL, 29.1% had an income between 30.001 and 50.000 TL and 8.9% had an income of 50.001 TL or more.

An examination of the participants' frequency of physician visits in the past year reveals that 62.1% visited a physician 1–5 times, 19.7% 6–10 times and 8.5% 11 or more times. Furthermore, 17.3% of participants had a chronic disease while 82.7% did not. These findings demonstrate that the sample was heterogeneous in terms of age, gender, education, income and health status, representing different sociodemographic groups. To determine participants' usage of physician rating sites several questions were asked. Data regarding the questions and participant responses are presented in Table 2.

Table 2. Findings Regarding the Use of Physician Rating Sites

Variables		n	%
Have you ever visited an internet-based physician rating site?	Yes	223	52.8
	No	198	46.9
Have you written comments on physician rating sites?	Yes	87	20.6
	No	333	78.9
How many times have you commented?*	1-4	65	74.7
	5 ≥	22	25.3

* The number of participants who answered the question is not 100%

Participants were asked whether they had ever used an internet-based physician rating site. 52.8% reported having visited such platforms while 46.9% had not. However, active engagement with these platforms was limited as 78.9% of participants reported that they had never written comments. These findings indicate that participants primarily use these platforms as passive information sources rather than interactive environments.

Data on which sites the participants actively use and the reasons for using the sites are given in Table 3.

Table 3. Findings regarding participants reasons for using physician rating sites.

		n
Which physician rating site do you use most?	Doktor Takvimi	138
	Doktorum	101
	Doktor Sitesi	94
	Bulut Klinik	10
What are your reasons for using physician rating sites?*	Read physician reviews	170
	Make an appointment	156
	Access personal feedback from physicians	83
	Reach your favorite physician	128

Participants were asked which physician rating sites they actively use and they were able to provide multiple answers. Participants were most likely to use the "Doktor Takvimi" site. The least frequently used site was "Bulut Klinik". Participants reported that the most common reason for using physician rating platforms was to read other users' comments about physicians. Other motivations included making appointments and identifying

preferred physicians. This suggests that user-generated content plays a central role in how individuals engage with these platforms.

Participants' responses to the six-item Likert-type scale indicated generally high agreement levels. The highest mean scores were observed for items related to the influence of physicians' responses to comments (4.17) and positive evaluations leading to treatment preference (4.04). Lower mean scores were observed for behavioral change (I5, 3.61) and perceived credibility of comments (I6, 3.53). These results suggest that while participants are influenced by online evaluations, their level of trust in such information is relatively moderate.

Table 4. Kaiser-Meyer-Olkin (KMO), Bartlett Test and Reliability Analysis.

	KMO	Bartlett's Test X ²	Df	Sig	% Explained Variance	Cronbach's Alpha	Number of Items
Scale on the Impact of Online Physician Ratings on Patient Preferences	0.805	335.73	15	.001	35.37	0.741	6

Exploratory factor analysis (EFA) was conducted to assess the construct validity of the scale. The Kaiser–Meyer–Olkin (KMO) value was found to be 0.805 and Bartlett's test of sphericity was statistically significant (χ^2 (15)=335.73, $p<.001$), indicating that the data were suitable for factor analysis. The analysis revealed a single-factor structure explaining 35.37% of the total variance. Although this value may appear modest, it exceeds the commonly accepted threshold of 30% for unidimensional structures in social sciences, indicating an acceptable level of construct representation¹⁴.

The internal consistency of the scale was assessed using Cronbach's Alpha, which was calculated as 0.741, demonstrating an acceptable level of reliability. The normality of the data was assessed using skewness and kurtosis values and all values were within the acceptable range (± 2), indicating that the data were approximately normally distributed. Therefore, parametric tests were used.

Table 5. Factor Loadings from Exploratory Analysis

Item	Factor Loading
I1	0.704
I2	0.546
I3	0.689
I4	0.683
I5	0.329
I6	0.527

Table 5 presents the factor loadings obtained from the exploratory factor analysis. The results indicate that the scale has a unidimensional structure, with factor loadings ranging between 0.329 and 0.704. Items I1, I3 and I4 demonstrated relatively high loadings, indicating that these items strongly represent the underlying construct. Items I2 and I6 showed moderate factor loadings, suggesting that they also contribute meaningfully to the factor structure. Overall, these findings support the structural coherence of the scale and confirm that the items collectively measure a single construct related to the perceived impact of online physician ratings on patient preferences.

Although item I5 exhibited the lowest factor loading (0.329), it was retained in the scale due to its conceptual importance. Unlike the other items, which primarily reflect perceptual and evaluative aspects this item captures behavioral intention in the form of physician switching. In addition, item-level analysis indicated that removing this item did not substantially improve the overall reliability of the scale. Therefore, the item was preserved to maintain the theoretical integrity and comprehensiveness of the construct.

Independent samples t-test results indicated that there was no statistically significant difference in scale scores based on gender ($t=-0.49$, $p>.05$). Similarly, no significant differences were found based on age, marital status or income level ($p>.05$). However, one-way ANOVA results revealed a statistically significant difference based on education level ($F=2.31$, $p=.020$). Post-hoc comparisons using Tukey indicated that participants with postgraduate education levels were significantly less influenced by online physician ratings compared to those with high school ($p=.025$) and middle school ($p=.004$) education levels. These findings suggest that higher education is associated with a reduced reliance on online physician rating platforms¹⁵.

To further examine the impact dimension of the study, regression analyses were conducted. First, a simple linear regression analysis was performed to assess the effect of perceived credibility. The results indicated that perceived credibility significantly predicted the impact of online physician ratings ($\beta=0.472$, $p<.001$), explaining 41.9% of

the variance ($R^2=.419$). The results of the multiple regression analysis are presented in Table 6.

Table 6. Multiple Regression Analysis Results Predicting Impact on Patient Preferences.

	B	SE	β	t	p
Constant	2.262	0.191	—	11.867	<.001
Perceived credibility (I6)	0.468	0.035	0.468	13.565	<.001
Site usage	-0.051	0.072	-0.051	-0.706	.481
Gender (Female)	-0.049	0.074	-0.049	-0.657	.512

Note. $R^2=.437$, $F(7, 256)=28.40$, $p<.001$. VIF values were below 5, indicating no multicollinearity issues.

A multiple regression analysis was conducted including perceived credibility, site usage, education level and gender as predictors. The model was statistically significant ($F=28.40$, $p<.001$) and explained a substantial proportion of the variance in patient preferences ($R^2=.437$), indicating strong explanatory power. Among the predictors, perceived credibility was the only statistically significant predictor ($\beta=0.468$, $p<.001$), underscoring its dominant role in shaping patient preferences. In contrast, site usage ($p=.481$) and gender ($p=.512$) did not have a significant effect.

Although education level showed a statistically significant difference in the ANOVA analysis, it did not remain a significant predictor in the regression model. This finding suggests that the effect of education may operate indirectly potentially through mechanisms such as perceived credibility.

Multicollinearity diagnostics indicated no significant issues ($VIF<5$) and all regression assumptions were satisfied, supporting the robustness of the model. Overall, the findings clearly demonstrate that while online physician rating platforms are widely used as information sources, their influence on patient preferences is primarily driven by perceived credibility rather than mere usage or demographic characteristics.

Discussion

This research aims to examine individuals' use of physician rating websites and their impact on healthcare-seeking behavior. The lack of studies in this area in the Turkish literature highlights the study's unique value. The study's primary objective is to contribute to the literature by filling this gap.

In recent years, the increasingly effective use of technology in the healthcare field has shifted individuals' health information-seeking behaviors to the internet⁸. These developments have led to a rapid increase in the number of online platforms where

patients can publicly share their experiences with healthcare institutions, physicians, and healthcare professionals. Physician rating sites enable the evaluation of patient-care interactions in a web-based environment, making perceptions about healthcare providers' performance visible. Thus, patients can share their own experiences with physicians and services with the public through these sites, providing feedback on the process. This can also help other patients form their own opinions about the process⁷.

In the study, 52.8% of participants reported having previously visited a physician rating website. A study by Terlutter, Bidmon, and Röttl¹⁶ found that 29% of participants were familiar with the sites. In a study conducted by Holliday, Kachalia, Meyer, and Sequist¹⁷ with 808 physicians and 494 patients, 53% of physicians and 39% of patients reported visiting a physician rating website at least once. This suggests that awareness of physician rating sites has increased over the years, largely due to the active introduction of technology. When examining whether participants actively use physician rating sites through comments, only 20.6% of participants commented on the sites. Similar studies, for example, found that 7% of patients reported their online experiences after an office visit. McLenan¹⁸ concluded that only 23% of participants commented on a physician rating site at least once. It appears that very few users actively contribute to the sites. This suggests that, despite high awareness of the sites, individuals refrain from commenting on them. To explore this, participants were asked about their reasons for not commenting on the sites. Participants cited reasons such as not finding physician rating sites reliable, not seeing the need to comment and the sites' membership issues being a hassle. A study published by Patel, Cain, Neailey and Hooberman¹⁹ examined patients' opinions on rating GPs on physician rating sites in the context of other feedback methods available in the UK. Participants reported that they would not leave feedback on such sites due to accessibility issues, privacy and security concerns, and a feeling that feedback left on a website could be ignored. Hanauer and colleagues⁷ in their study conducted in the United States, asked participants to consider the impact of leaving negative reviews about a physician. Participants reported concerns that their identities could be compromised and that physicians could take action against them for leaving negative reviews. This supports the existence of trust issues, such as participants disclosing personal information to physician rating sites, that also emerged in our study.

An evaluation of participants' attitudes suggests that negative comments on web-based platforms may lead to concerns about "stigmatization" of physicians, leading users to share more positive experiences. This finding is consistent with Lagu et al.'s²⁰ study of comments on physician rating sites, which found that 88% of the posts were positive. Similarly, a study conducted in China found that serious illness experiences and positive healthcare experiences were among the primary determinants of evaluation behavior⁵. Therefore, both our current study and previous research demonstrate that positive comments predominate on physician rating sites, and that positive medical experiences play a significant predictive role in patient evaluations.

Participants found that the most frequently used physician rating site was "Doktor Takvimi." According to a report prepared by the Doktor Takvimi site, 73 million people

visited the site in 2023 and 13 million patients/clients interacted with it²¹. The report's findings support the fact that Doktor Takvimi is the most actively used physician rating site in Turkey.

According to the research findings, participants' primary purposes for using physician rating sites include reviewing physician reviews, scheduling appointments, and finding the most preferred physician. Similarly, in a study conducted by Mclenan¹⁸, 31.8% of participants stated that they viewed physician rating sites as an important source of information. These findings demonstrate that these sites serve as an important reference point for individuals seeking information about physicians during the physician selection process.

When examining the impact of reviews on physician rating sites on physician selection, participants stated that both positive and negative reviews were decisive in the decision-making process. Similarly, a study by Hauner et al.⁷ found that physicians with positive reviews were more preferred, while those with negative reviews were avoided by patients. Burkle and Keegan's²² study supports these findings, demonstrating that positive reviews influence patient preference, while negative reviews discourage patients from choosing a physician. Therefore, physician rating sites are important digital platforms that enable patients to provide feedback about their healthcare providers, thereby contributing to informed decision-making by patients.

When examining the relationships between demographic variables and physician preference in our study, a significant difference was found only between education level and physician preference. The findings indicate that the influence of online physician reviews on patient preferences decreases with increasing education level. This may be explained by the fact that highly educated individuals possess more advanced health literacy and critical thinking skills. These individuals are more likely to question the credibility of online reviews and prioritize other sources of information, as well as their own personal experiences, in their decision-making processes.

In addition to descriptive findings, the regression analysis conducted in this study provides a deeper understanding of the mechanisms underlying patient preferences. The results demonstrated that perceived credibility of online physician ratings is a strong and significant predictor of their impact on patient preferences. This finding suggests that the influence of physician rating platforms is not determined merely by their usage, but rather by the extent to which individuals trust the information presented on these platforms.

This result is consistent with previous research emphasizing the importance of trust in online health information²³. Individuals tend to rely more on digital health sources when they perceive them as credible, whereas low levels of trust reduce the influence of such platforms on decision-making. Therefore, perceived credibility appears to function as a key mechanism linking online information exposure to behavioral outcomes.

Limitations

This study has some limitations. The data are based on participants' reports of their site usage, which may be affected by individual perceptions and potential response bias. While the sample size is sufficient for statistical analysis, the findings may be context-dependent and should be interpreted within the study's population context. Finally, the study focuses on general perceptions of online physician review platforms and does not include platform-specific or behavioural data that could provide additional insights into user decision-making processes. Future studies may benefit from using different research designs and data sources to further validate and expand these findings.

Conclusion

This study reveals an awareness of physician rating sites in Türkiye. However, an examination of usage revealed a discrepancy between awareness and usage. While participants tended to read reviews on these sites, they were inactive in commenting individually. The primary reasons for this inactivity were trust issues with the sites and the difficulties associated with membership processes. The findings also indicate that participants are influenced by reviews on physician rating sites and tend to switch physicians based on these reviews. Given the information asymmetry between healthcare providers and patients, it is understandable that individuals gravitate towards public information not based on personal experiences and consider other users' reviews as reliable sources.

The study examined relationships between sociodemographic variables, perceptions and behaviors toward physician rating websites. It found significant differences across education levels. The growing number of physician rating websites marks a significant step in strengthening patient-physician communication. These platforms promote a patient-centered approach to care. When patients share experiences publicly it increases transparency and helps providers improve their performance. Monitoring satisfaction levels also becomes easier. Yet, these sites bring challenges due to the unique nature of healthcare. Physicians may argue that their evaluations are unfair or that ratings do not fully reflect reality. Verifying the accuracy of reviews and carefully regulating publication policies is therefore crucial.

In conclusion, increasing the visibility and diversity of physician rating sites is seen as valuable for technological transformation and access to information in healthcare. Furthermore, the site's security policies should be made transparent, user-friendly interfaces should be improved and terms of use should be made more flexible. Future research should provide a more in-depth understanding of the process by conducting content analysis of comments on actively used physician rating sites and examining the sectoral relevance of their usage policies.

REFERENCES

1. Rothenfluh F, Schulz PJ. Content, quality, and assessment tools of physician-rating websites in 12 countries: Quantitative analysis. *J Med Internet Res*. 2018;20(6):e212.
2. Brown BJ, Carroll J, Boon H, Marmoreo J. Women's decision making about their health care: Views over the life cycle. *Patient Educ Couns*. 2002;48(3):225-231.
3. Huber TJ, Cruz JM. Information needs and information-seeking behaviors of HIV positive men and women. *Med Ref Serv Q*. 2000;19(3):39-48. doi:10.1300/J115v19n03_04. Accessed October 10, 2024. <https://tibbinustalari.com/doktortakvimi-2023-yili-sektor-verilerini-acikladi/>.
4. Stoumpos AI, Kitsios F, Talias MA. Digital transformation in healthcare: Technology acceptance and its applications. *Int J Environ Res Public Health*. 2023;20(4):3407.
5. Han X, Li B, Zhang T, Qu J. Factors associated with the actual behavior and intention of rating physicians on physician-rating websites: Cross-sectional study. *J Med Internet Res*. 2020;22(6):e14417. doi: 10.2196/14417.
6. Verhoef LM, Van de Belt TH, Engelen LJ, Schoonhoven L, Kool RB. Social media and rating sites as tools to understanding quality of care: A scoping review. *J Med Internet Res*. 2014;16(2):e3024. doi: 10.2196/jmir.3024.
7. Hanauer DA, Zheng K, Singer DC, Gebremariam A, Davis MM. Public awareness, perception, and use of online physician rating sites. *JAMA*. 2014;311(7):734-735.
8. Syed UA, Acevedo D, Narzikul AC, Coomer W, Beredjiklian PK, Abboud JA. Physician rating websites: An analysis of physician evaluation and physician perception. *Arch Bone Jt Surg*. 2019;7(2):136.
9. Bidmon S, Elshiewy O, Terlutter R, Boztug Y. What patients value in physicians: Analyzing drivers of patient satisfaction using physician-rating website data. *J Med Internet Res*. 2020;22(2):e13830. doi: 10.2196/13830.
10. Lu W, Wu H. How online reviews and services affect physician outpatient visits: Content analysis of evidence from two online healthcare communities. *JMIR Med Inform*. 2019;7(4):e16185. doi: 10.2196/16185.
11. Hong YA, Liang C, Radcliff TA, Wigfall LT, Street RL. What do patients say about doctors online? A systematic review of studies on patient online reviews. *J Med Internet Res*. 2019;21(4):e12521. doi: 10.2196/12521.
12. Collins M. Sampling. In: Worcester RM, Downham J, eds. *Consumer Market Research Handbook*. 3rd ed. London: McGraw-Hill; 1986:85-110.

13. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ*. 2011;2: 53-55.
14. Çokluk, Ö. Şekercioğlu G. Büyüköztürk Ş. *Sosyal Bilimler İçin Çok Değişkenli İstatistik*. PEGEM Yayınları: Ankara. 2010.
15. George D, Mallery M. *SPSS for Windows Step by Step: A Simple Guide and Reference*. 10th ed. Boston: Pearson; 2010.
16. Terlutter R, Bidmon S, Röttl J. Who uses physician-rating websites? Differences in sociodemographic variables, psychographic variables, and health status of users and nonusers of physician-rating websites. *J Med Internet Res*. 2014;16(3):e97.
17. Holliday AM, Kachalia A, Meyer GS, Sequist TD. Physician and patient views on public physician rating websites: A cross-sectional study. *J Gen Intern Med*. 2017;32:626-631.
18. McLennan S. Quantitative ratings and narrative comments on Swiss physician rating websites: Frequency analysis. *J Med Internet Res*. 2019;21(7):e13816. doi: 10.2196/13816.
19. Patel S, Cain R, Neailey K, Hooberman L. Exploring patients' views toward giving web-based feedback and ratings to general practitioners in England: A qualitative descriptive study. *J Med Internet Res*. 2016;18(8):e217. doi: 10.2196/jmir.5865.
20. Lagu T, Hannon NS, Rothberg MB, Lindenauer PK. Patients' evaluations of healthcare providers in the era of social networking: An analysis of rating websites. *J Gen Intern Med*. 2010;25(9):942-946. doi: 10.1007/s11606-010-1383-0.
21. Tıbbın Ustaları. DoktorTakvimi, 2023 yılı sektör verilerini açıkladı. Tıbbın Ustaları. <https://tibbinustalari.com/dokortakvimi-2023-yili-sektor-verilerini-acikladi/>. Published January 26, 2024. Accessed October 10, 2024.
22. Burkle CM, Keegan MT. Popularity of internet physician rating sites and their apparent influence on patients' choices of physicians. *BMC Health Serv Res*. 2015;15: 1180.
23. Sbaffi L, Rowley J. Trust and credibility in web-based health information: A review and agenda for future research. *Journal for Future Research*. 2017; 19(6): E218. DOI: 10.2196/jmir.7579.

Association of Embryology Education with Infertility Knowledge and Attitudes among Medical and Health Sciences Students

Emrah ZAYMAN*, Feyza İNCEOĞLU**

Abstract

Aim: The aim of this study is to compare infertility-related knowledge and attitudes among students from the Faculty of Medicine (basic and clinical phases) and the Faculty of Health Sciences (midwifery and nursing programs), and to investigate the association between embryology education and students' knowledge and attitudes toward infertility.

Method: This cross-sectional study included 228 undergraduate students from the Faculties of Medicine and Health Sciences. The sample size was determined by power analysis and participants were recruited using the snowball sampling method. Data were collected through an online questionnaire consisting of a sociodemographic information form, infertility knowledge questions and the "Attitude Scale Toward Infertility". Statistical analyses were performed using R version 4.3.1. Chi-square, independent samples t-test, Mann Whitney U, and Kruskal Wallis tests were applied as appropriate.

Results: Students' responses to the infertility knowledge questions differed significantly according to gender, academic program, year of study, and receipt of embryology education ($p < 0.05$). Medical students had significantly higher attitude scores toward infertility than health sciences students (47.81 ± 7.58 vs. 36.72 ± 3.62 ; $t = -14.089$, $p < 0.001$). Likewise, students who had received embryology education demonstrated significantly higher attitude scores than those who had not (44.76 ± 8.31 vs. 37.64 ± 5.28 ; $t = 6.947$, $p < 0.001$).

Conclusion: Medical students and students who had received embryology education exhibited greater infertility-related knowledge and more positive attitudes toward infertility than their counterparts. These findings suggest that strengthening embryology education may improve clinical awareness of infertility, support future healthcare professionals in the accurate management of infertility, facilitate psychosocial care, and contribute to reducing infertility-related social stigma.

Keywords: Embryology education, infertility awareness, health professional candidates, attitude scale.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 23.06.2026 **Kabul / Accepted:** 04.08.2026

DOI: <https://doi.org/10.38079/igusabder.1974668>

* Asst. Prof. Dr., Malatya Turgut Özal University, Faculty of Medicine, Department of Histology and Embryology, Malatya, Türkiye. E-mail: emrah.zayman@ozal.edu.tr ORCID <https://orcid.org/0000-0002-6578-3371>

** Assoc. Prof. Dr., Malatya Turgut Özal University, Faculty of Medicine, Department of Biostatistics, Malatya, Türkiye. E-mail: feyza.inceoglu@ozal.edu.tr ORCID <https://orcid.org/0000-0003-1453-0937>

ETHICAL STATEMENT: The protocol was approved by the Health Sciences Scientific Research Committee of the Malatya Turgut Özal University, Türkiye (Number: E-30785963-020-388205, Date: 24.04.2026).

Tıp ve Sağlık Bilimleri Öğrencileri Arasında Embriyoloji Eğitimi ile Kısırlık Konusundaki Bilgi ve Tutumlar Arasındaki İlişki

Amaç: Bu çalışmanın amacı, Tıp Fakültesi (temel ve klinik tıp dönemleri) ve Sağlık Bilimleri Fakültesi (ebelik ve hemşirelik bölümleri) öğrencileri için embriyoloji eğitimi almanın, sosyodemografik değişkenlerin infertilite konusundaki bilgi ve tutum düzeyleri üzerindeki etkisini belirlemektir.

Yöntem: Kesitsel çalışmanın örnekleme güç analizi ile belirlendi ve kartopu örnekleme yöntemiyle tıp ve sağlık bilimleri fakültelerinden toplam 228 lisans öğrencisi çalışmaya alındı. Veriler; sosyodemografik bilgi formu, infertilite bilgisi ile ilgili sorular ve "İnfertilite Tutum Ölçeği" içeren çevrimiçi bir anket aracılığıyla toplandı. İstatistiksel analizler R 4.3.1 programı kullanılarak yapıldı, ki-kare, t-testi, Mann Whitney U ve Kruskal Wallis analizleri kullanıldı.

Bulgular: Öğrencilerin infertilite bilgisi ile ilgili sorulara verdikleri yanıtlar cinsiyet, bölüm, sınıf ve embriyoloji eğitim durumu açısından istatistiksel olarak anlamlı farklılık göstermiştir ($p < 0,05$). Tıp öğrencilerinin kısırlık konusundaki tutum puanları ($47,81 \pm 7,58$), sağlık bilimleri öğrencilerinin ($36,72 \pm 3,62$) puanlarından anlamlı derecede yüksek bulundu ($t = -14,089$, $p < 0,001$). Müfredatta embriyoloji eğitimi alan öğrencilerin tutum puanlarının ($44,76 \pm 8,31$) almayanlara ($37,64 \pm 5,28$) göre daha yüksek olduğu ve bu farkın istatistiksel olarak anlamlı olduğu bulundu ($t = 6,947$, $p < 0,001$).

Sonuç: Araştırma bulguları, tıp öğrencilerinin ve müfredatında embriyoloji eğitimi olan grupların, infertilite konusunda daha iyi bir bilgi düzeyine ve daha olumlu/yüksek farkındalığa sahip tutum sergilediklerini göstermektedir. Gelecekteki sağlık profesyonellerinin infertilite klinik tablosunu doğru bir şekilde yönetmelerini, psikososyal destek süreçlerini planlamalarını ve sosyal damgalamayı önlemelerini sağlamak için klinik farkındalığı desteklemek amacıyla embriyoloji eğitiminin güçlendirilmesi önerilmektedir.

Anahtar Sözcükler: Embriyoloji eğitimi, infertilite farkındalığı, sağlık profesyoneli adayları, tutum ölçeği.

Introduction

Prenatal development from fertilization to birth, including the mechanisms of morphogenesis and organogenesis at the tissue, cellular, and molecular levels, is the focus of embryology, a fundamental medical science. In modern medical education, embryology is generally taught during the first three years of medical school, either as part of histology or as an independent course^{1,2}. In faculties of health sciences, subjects related to reproductive health, childbirth, and obstetrics provide the basic scientific foundation for nursing and midwifery education³. Because infertility is closely associated with abnormalities in gametogenesis, fertilization, and embryonic development, a sound understanding of embryology is essential for healthcare professionals involved in infertility diagnosis, treatment, and assisted reproductive technologies^{4,5}.

Several studies have evaluated the knowledge and attitudes of future healthcare professionals toward infertility. Previous research indicates that health sciences students often have limited biological and clinical knowledge of infertility⁶. Although nursing and midwifery students generally demonstrate positive attitudes toward infertility, deficiencies remain regarding current assisted reproductive technologies and laboratory procedures^{7,8}. Similarly, medical students have been reported to possess adequate theoretical knowledge of reproductive health and fertility awareness but insufficient

embryological knowledge and practical understanding, partly because embryology is perceived as a complex three-dimensional subject¹.

To our knowledge, no previous study has compared infertility-related knowledge and attitudes among basic medicine (preclinic, Years 1–3) and clinical (Years 4–6) medical students and students from nursing and midwifery programs. Furthermore, it remains unclear how embryology education during the basic medicine years influences infertility awareness independently of clinical obstetrics and gynecology training. The progressive reduction in embryology teaching hours and the limited emphasis on its clinical relevance have raised concerns regarding students' preparedness². By comparing students at different educational stages and across health disciplines, this study aims to clarify the contribution of embryology education to infertility knowledge, clinical awareness, and attitudes toward infertility.

The aim of this study was to determine infertility-related knowledge, attitudes, and their association with sociodemographic characteristics among medical students (basic and clinical phases) and health sciences students enrolled in nursing and midwifery programs.

Material and Methods

Sample Size and Sampling Method

The required sample size was determined using G*Power 3.1. With an effect size of 0.44, a power of 0.95, and a confidence level, the sample size was determined to be 113 for each groups^{9,10}.

The snowball sampling method was used to recruit participants for the study. According to the General Data Protection Regulation (GDPR) and the principles of Open Science and research evaluation, the "European Code of Conduct for Research Integrity" (2023) highlights the impact of social media on the research data-collection process alongside technological developments¹¹. During data collection, the questionnaires were prepared in accordance with the principles of respect for individuals' privacy, scientific integrity, social responsibility, and scientific benefit in online research, as outlined by the British Psychological Society¹². According to Creswell, reaching individuals who can provide data and distributing questionnaires to them is advantageous for obtaining high-quality data¹³. In line with these views, participants were recruited using the snowball sampling method. Online communities involving different student groups were selected as starting points. The questionnaire was configured to allow only one response per participant and was then distributed. Before receiving the questionnaire, participants were presented with the "Informed Voluntary Consent Form"; data collection commenced after consent was obtained. Cookies and IP addresses were checked to verify the integrity of the collected data.

Inclusion and Exclusion Criteria

Students from the Faculties of Medicine and Health Sciences (nursing and midwifery) who provided informed voluntary consent and did not have any psychological disorders were included in the study.

Students who completed the questionnaires incompletely or incorrectly, as well as those who did not consent to participate, were excluded from the study.

Data Collection Forms

The questionnaire consisted of three sections. The first section included a sociodemographic data form covering age, gender, faculty and academic department, year of study, chronic illness, smoking and alcohol use, a history of infertility in the family or close circle, and receipt of embryology education. The second section included questions assessing infertility awareness. The third section included the "Attitude Toward Infertility Scale".

Attitude Toward Infertility Scale

The scale, developed by Siyez and colleagues in 2018, consists of 12 items and uses a five-point Likert-type response format: "(1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, (5) Strongly Agree)." Items 1, 2, 5, 6, 8, 9, 11, and 12 are reverse-scored. The maximum possible score is 60, and the minimum possible score is 12. Higher scores indicate a more positive attitude toward infertility. The scale's Cronbach's alpha was 0.85⁶.

Ethical Statement

The protocol was approved by the Health Sciences Scientific Research Committee of Malatya Turgut Ozal University, Türkiye (No.: E-30785963-020-388205; date: 24 April 2026).

Data Analysis

Data were analyzed using the open-source program R (version 4.3.1). Statistical significance was set at $p < 0.05$. Descriptive statistics were presented as means, standard deviations, medians, counts, and percentages. For the comparison tests, the normality assumption was assessed using the Kolmogorov-Smirnov test. For groups with a normal distribution, pairwise comparisons were performed using the independent-samples t-test. For groups that were not normally distributed, pairwise comparisons were performed using the Mann-Whitney U test. For independent variables involving multiple groups that were not normally distributed, the Kruskal-Wallis test was applied; for pairwise comparisons, the Bonferroni-adjusted Mann-Whitney U test was used. For categorical data, contingency tables were created, and chi-square tests were performed.

Results

Table 1 presents a comparison of the sociodemographic characteristics of students in the Faculties of Medicine and Health Sciences. Statistically significant differences between the two faculties were found in gender ($\chi^2=9.432$, $p=0.002$), department ($\chi^2=228.000$, $p<0.001$), year of study ($\chi^2=62.392$, $p<0.001$), and smoking habits ($\chi^2=67.772$, $p<0.001$). However, no statistically significant differences were found between the Faculties of Medicine and Health Sciences in alcohol use ($\chi^2=1.060$, $p=0.589$) or chronic disease ($\chi^2=3.508$, $p=0.061$). A statistically significant difference was also found between the faculties regarding receipt of embryology education ($\chi^2=94.358$, $p<0.001$; Table 1).

Table 1. Comparison of demographic characteristics.

Variables	Groups	Health Science (n/%)	Medicine (n/%)	Total (n/%)	χ^2	p
Gender	Male	28 (24.56%)	50 (43.86%)	78 (34.21%)	9.432	0.002*
	Female	86 (75.44%)	64 (56.14%)	150 (65.79%)		
Department	Midwifery	69 (60.53%)	-	69 (30.26%)	228.000	<0.001*
	Nursing	45 (39.47%)	-	45 (19.74%)		
	Medicine	-	114 (100.00%)	114 (50.00%)		
Class	Class-1	24 (21.05%)	5 (4.39%)	29 (12.72%)	62.392	<0.001*
	Class-2	20 (17.54%)	55 (48.25%)	75 (32.89%)		
	Class-3	50 (43.86%)	16 (14.04%)	66 (28.95%)		
	Class-4	20 (17.54%)	22 (19.30%)	42 (18.42%)		
	Class-5	-	6 (5.26%)	6 (2.63%)		
	Class-6	-	10 (8.77%)	10 (4.39%)		
Smoking	Yes	84 (73.68%)	22 (19.30%)	106 (46.49%)	67.772	<0.001*
	No	30 (26.32%)	92 (80.70%)	122 (53.51%)		
Alcohol Use	Yes	14 (12.28%)	12 (10.53%)	25 (11.40%)	1.060	0.589
	No	100 (87.72%)	102 (89.47%)	202 (88.60%)		
Chronic Disease	Yes	14 (12.28%)	6 (5.26%)	20 (8.77%)	3.508	0.061

	No	100 (87.72%)	108 (94.74%)	208 (91.23%)		
Embryology Training	Yes	39 (34.21%)	109 (95.61%)	148 (64.91%)	94.358	<0.001*
	No	75 (65.79%)	5 (4.39%)	80 (35.09%)		

n; frequency, %; percent, χ^2 ; chi-square test, *p<0.05

Table 2 compares the responses to the infertility knowledge questions among students from the Faculties of Medicine and Health Sciences. Statistically significant differences in response distributions were found for questions 1, 2, and 4 to 12 (p<0.05). However, no statistically significant difference was found in the response distribution for question 3 (p>0.05).

Table 2. Comparison of infertility knowledge levels among students from the Faculties of Health Sciences and Medicine.

Variable	Group	Health Science (n/%)	Medicine (n/%)	Total (n/%)	χ^2	p
1. Infertility is a disease.	Yes	29 (25.44%)	79 (69.30%)	108 (47.37%)	43.981	<0.001*
	No	85 (74.56%)	35 (30.70%)	120 (52.63%)		
2. Infertility is more common in women than in men.	Yes	14 (12.28%)	48 (42.11%)	62 (27.19%)	25.609	<0.001*
	No	100 (87.72%)	66 (57.89%)	166 (72.81%)		
3. Infertility is more common in men than in women.	Yes	28 (24.56%)	27 (23.68%)	55 (24.12%)	0.024	0.877
	No	86 (75.44%)	87 (76.32%)	173 (75.88%)		
4. The incidence of infertility is equal in women and men.	Yes	71 (62.28%)	43 (37.72%)	114 (50.00%)	13.754	<0.001*
	No	43 (37.72%)	71 (62.28%)	114 (50.00%)		
5. Infertility is a condition that requires treatment.	Yes	43 (37.72%)	105 (92.11%)	148 (64.91%)	74.023	<0.001*
	No	71 (62.28%)	9 (7.89%)	80 (35.09%)		
	Yes	43 (37.72%)	6 (5.26%)	49 (21.49%)	35.587	<0.001*

6. In infertility treatment, in vitro fertilization (IVF) is the definitive solution.	No	71 (62.28%)	108 (94.74%)	179 (78.51%)		
7. In infertility treatment, artificial insemination is a definitive solution.	Yes	29 (25.44%)	7 (6.14%)	36 (15.79%)	15.965	<0.001*
	No	85 (74.56%)	107 (93.86%)	192 (84.21%)		
8. I understand that 12 months of unprotected intercourse is required for diagnosis in individuals with infertility.	Yes	44 (38.60%)	81 (71.05%)	125 (54.82%)	24.243	<0.001*
	No	70 (61.40%)	33 (28.95%)	103 (45.18%)		
9. In an approach to infertile couples, psychosocial support is necessary alongside medical treatment.	Yes	44 (38.60%)	113 (99.12%)	157 (68.86%)	97.381	<0.001*
	No	70 (61.40%)	1 (0.88%)	71 (31.14%)		
10. An embryo is formed by the fusion of male and female reproductive cells.	Yes	71 (62.28%)	110 (96.49%)	181 (79.39%)	40.765	<0.001*
	No	43 (37.72%)	4 (3.51%)	47 (20.61%)		
11. Staying up-to-date with current technological advancements in infertility treatment contributes to my professional development.	Yes	72 (63.16%)	108 (94.74%)	180 (78.95%)	34.200	<0.001*
	No	42 (36.84%)	6 (5.26%)	48 (21.05%)		
12. When approaching an individual diagnosed with infertility, I consider the risk of stigma (social discrimination).	Yes	71 (62.28%)	100 (87.72%)	171 (75.00%)	19.673	<0.001*
	No	43 (37.72%)	14 (12.28%)	57 (25.00%)		

n; frequency, %; percent, χ^2 ; chi-square test, * $p < 0.05$

Table 3 compares responses to the infertility knowledge questions among students with and without a history of infertility in their family or close social circle. Statistically significant differences in response distributions were found for questions 1, 3, 4, 8, 9, and 10 among students with and without a family or close-relative history of infertility ($p < 0.05$). No statistically significant differences were found for questions 2, 5, 6, 7, 11, and 12 between students with and without a history of infertility in their family or close social circle ($p > 0.05$).

Table 3. Comparison based on the presence of a family history of infertility.

Variable	Group	Family History of Infertility Yes (n/%)	Family History of Infertility No (n/%)	Total (n/%)	χ^2	p
1. Infertility is a disease.	Yes	39 (33.62%)	69 (61.61%)	108 (47.37%)	17.902	<0.001*
	No	77 (66.38%)	43 (38.39%)	120 (52.63%)		
2. Infertility is more common in women than in men.	Yes	29 (25.00%)	33 (29.46%)	62 (27.19%)	0.574	0.449
	No	87 (75.00%)	79 (70.54%)	166 (72.81%)		
3. Infertility is more common in men than in women.	Yes	19 (16.38%)	36 (32.14%)	55 (24.12%)	7.736	0.005*
	No	97 (83.62%)	76 (67.86%)	173 (75.88%)		
4. The incidence of infertility is equal in women and men.	Yes	67 (57.76%)	47 (41.96%)	114 (50.00%)	5.686	0.017*
	No	49 (42.24%)	65 (58.04%)	114 (50.00%)		
5. Infertility is a condition that requires treatment.	Yes	71 (61.21%)	77 (68.75%)	148 (64.91%)	1.424	0.233
	No	45 (38.79%)	35 (31.25%)	80 (35.09%)		
6. In infertility treatment, in vitro fertilization (IVF) is the definitive solution.	Yes	31 (26.72%)	18 (16.07%)	49 (21.49%)	3.832	0.050
	No	85 (73.28%)	94 (83.93%)	179 (78.51%)		
7. In infertility treatment, artificial insemination is a definitive solution.	Yes	16 (13.79%)	20 (17.86%)	36 (15.79%)	0.708	0.400
	No	100 (86.21%)	92 (82.14%)	192 (84.21%)		
8. I understand that 12 months of unprotected intercourse is required for diagnosis in individuals with infertility.	Yes	54 (46.55%)	71 (63.39%)	125 (54.82%)	6.525	0.011*
	No	62 (53.45%)	41 (36.61%)	103 (45.18%)		

9. In an approach to infertile couples, psychosocial support is necessary alongside medical treatment.	Yes	60 (51.72%)	97 (86.61%)	157 (68.86%)	32.336	<0.001*
	No	56 (48.28%)	15 (13.39%)	71 (31.14%)		
10. An embryo is formed by the fusion of male and female reproductive cells.	Yes	100 (86.21%)	81 (72.32%)	181 (79.39%)	6.714	0.010*
	No	16 (13.79%)	31 (27.68%)	47 (20.61%)		
11. Staying up-to-date with current technological advancements in infertility treatment contributes to my professional development.	Yes	86 (74.14%)	94 (83.93%)	180 (78.95%)	3.286	0.070
	No	30 (25.86%)	18 (16.07%)	48 (21.05%)		
12. When approaching an individual diagnosed with infertility, I consider the risk of stigma (social discrimination).	Yes	84 (72.41%)	87 (77.68%)	171 (75.00%)	0.842	0.359
	No	32 (27.59%)	25 (22.32%)	57 (25.00%)		

n; frequency, %; percent, χ^2 ; chi-square test, * $p < 0.05$

Table 4 presents the infertility knowledge of students who had and had not previously received embryology training. Statistically significant differences in response distributions were found for questions 1 to 11 between the two groups ($p < 0.05$). No statistically significant difference was found for question 12 ($p > 0.05$).

Table 4. Comparison based on receipt of embryology training.

Variable	Group	Embryology Training Yes (n/%)	Embryology Training No (n/%)	Total (n/%)	χ^2	p
1. Infertility is a disease.	Yes	88 (59.46%)	20 (25.00%)	108 (47.37%)	24.734	<0.001*
	No	60 (40.54%)	60 (75.00%)	120 (52.63%)		
2. Infertility is more common in women than in men.	Yes	58 (39.19%)	4 (5.00%)	62 (27.19%)	30.659	<0.001*
	No	90 (60.81%)	76 (95.00%)	166 (72.81%)		
3. Infertility is more common in men than in women.	Yes	45 (30.41%)	10 (12.50%)	55 (24.12%)	9.096	0.003*
	No	103 (69.59%)	70 (87.50%)	173 (75.88%)		

4. The incidence of infertility is equal in women and men.	Yes	59 (39.86%)	55 (68.75%)	114 (50.00%)	17.331	<0.001*
	No	89 (60.14%)	25 (31.25%)	114 (50.00%)		
5. Infertility is a condition that requires treatment.	Yes	118 (79.73%)	30 (37.50%)	148 (64.91%)	40.660	<0.001*
	No	30 (20.27%)	50 (62.50%)	80 (35.09%)		
6. In infertility treatment, in vitro fertilization (IVF) is the definitive solution.	Yes	13 (8.78%)	36 (45.00%)	49 (21.49%)	40.369	<0.001*
	No	135 (91.22%)	44 (55.00%)	179 (78.51%)		
7. In infertility treatment, artificial insemination is a definitive solution.	Yes	17 (11.49%)	19 (23.75%)	36 (15.79%)	5.874	0.015*
	No	131 (88.51%)	61 (76.25%)	192 (84.21%)		
8. I understand that 12 months of unprotected intercourse is required for diagnosis in individuals with infertility.	Yes	94 (63.51%)	31 (38.75%)	125 (54.82%)	12.858	<0.001*
	No	54 (36.49%)	49 (61.25%)	103 (45.18%)		
9. In an approach to infertile couples, psychosocial support is necessary alongside medical treatment.	Yes	115 (77.70%)	42 (52.50%)	157 (68.86%)	15.382	<0.001*
	No	33 (22.30%)	38 (47.50%)	71 (31.14%)		
10. An embryo is formed by the fusion of male and female reproductive cells.	Yes	133 (89.86%)	48 (60.00%)	181 (79.39%)	28.303	<0.001*
	No	15 (10.14%)	32 (40.00%)	47 (20.61%)		
11. Staying up-to-date with current technological advancements in infertility treatment contributes to my professional development.	Yes	128 (86.49%)	52 (65.00%)	180 (78.95%)	14.425	<0.001*
	No	20 (13.51%)	28 (35.00%)	48 (21.05%)		
12. When approaching an individual diagnosed with infertility, I consider the risk of stigma (social discrimination).	Yes	113 (76.35%)	58 (72.50%)	171 (75.00%)	0.411	0.522
	No	35 (23.65%)	22 (27.50%)	57 (25.00%)		

n; frequency, %; percent, χ^2 ; chi-square test, *p<0.05

Table 5 presents the Attitude Toward Infertility Scale scores and between-group comparisons. Students in the Faculty of Medicine had significantly higher attitude scores toward infertility than students in the Faculty of Health Sciences ($t=-14.089$, $p<0.001$). Similarly, students who had received embryology education had significantly higher attitude scores toward infertility than those who had not ($t=6.947$, $p<0.001$). The difference in Attitude Toward Infertility Scale scores between the faculties was not only statistically significant but also demonstrated a very large effect size (Cohen's $d=1.870$). Similarly, the difference associated with embryology training showed a large effect size (Cohen's $d=0.960$).

Table 5. Comparison of Attitude Toward Infertility Scale scores.

Variable	Group	Mean $\pm$ sd	t	p	Effect size
Faculty	Health Science	36.72 $\pm$ 3.62	-14.089	<0.001*	1.870
	Medicine	47.81 $\pm$ 7.58			
Embryology Training	Yes	44.76 $\pm$ 8.31	6.947	<0.001*	0.960
	No	37.64 $\pm$ 5.28			

sd; standard deviation, t; independent t test, * $p<0.05$

Table 6 compares responses to infertility-related questions among students in basic medical sciences, clinical medicine, midwifery, and nursing. A statistically significant difference was found in the distribution of responses between students who had and had not received embryology education ($\chi^2=132.581$, $p<0.001$).

Table 6. Comparison of embryology training status among students in basic medical sciences, clinical medicine, midwifery, and nursing.

Variable	Group	Midwifery (n/%)	Nursing (n/%)	Basic Medical Sciences (n/%)	Clinical Medicine Sciences (n/%)	Total (n/%)	χ^2	p
Embryology Training	Yes	39 (56.52%)	-	73 (96.05%)	36 (94.74%)	148 (64.91%)	132.581	<0.001*
	No	30 (43.48%)	45 (100.00%)	3 (3.95%)	2 (5.26%)	80 (35.09%)		

n; frequency, %; percent, χ^2 ; chi-square test, * $p<0.05$

Table 7 compares responses to infertility-related questions among students in basic medical sciences, clinical medicine, midwifery, and nursing. Statistically significant differences in response distributions were found for questions 1 to 12 among the four groups ($p<0.05$).

Table 7. Comparison of responses from students in basic medical sciences, clinical medicine, midwifery, and nursing.

Variable	Group	Midwifery (n/%)	Nursing (n/%)	Basic Medical Sciences (n/%)	Clinical Medicine Sciences (n/%)	Total (n/%)	χ^2	p
1. Infertility is a disease.	Yes	14 (20.29%)	15 (33.33%)	57 (75.00%)	22 (57.89%)	108 (47.37%)	48.813	<0.001*
	No	55 (79.71%)	30 (66.67%)	19 (25.00%)	16 (42.11%)	120 (52.63%)		
2. Infertility is more common in women than in men.	Yes	14 (20.29%)	-	28 (36.84%)	20 (52.63%)	62 (27.19%)	34.463	<0.001*
	No	55 (79.71%)	45 (100.00%)	48 (63.16%)	18 (47.37%)	166 (72.81%)		
3. Infertility is more common in men than in women.	Yes	28 (40.58%)	-	23 (30.26%)	4 (10.53%)	55 (24.12%)	29.919	<0.001*
	No	41 (59.42%)	45 (100.00%)	53 (69.74%)	34 (89.47%)	173 (75.88%)		
4. The incidence of infertility is equal in women and men.	Yes	41 (59.42%)	30 (66.67%)	29 (38.16%)	14 (36.84%)	114 (50.00%)	14.344	0.002*
	No	28 (40.58%)	15 (33.33%)	47 (61.84%)	24 (63.16%)	114 (50.00%)		
5. Infertility is a condition that requires treatment.	Yes	28 (40.58%)	15 (33.33%)	71 (93.42%)	34 (89.47%)	148 (64.91%)	74.824	<0.001*
	No	41 (59.42%)	30 (66.67%)	5 (6.58%)	4 (10.53%)	80 (35.09%)		
6. In infertility treatment, in vitro fertilization (IVF) is the definitive solution.	Yes	14 (20.29%)	29 (64.44%)	3 (3.95%)	3 (7.89%)	49 (21.49%)	67.293	<0.001*
	No	55 (79.71%)	16 (35.56%)	73 (96.05%)	35 (92.11%)	179 (78.51%)		
7. In infertility treatment, artificial insemination is a definitive solution.	Yes	14 (20.29%)	15 (33.33%)	4 (5.26%)	3 (7.89%)	36 (15.79%)	19.582	<0.001*
	No	55 (79.71%)	30 (66.67%)	72 (94.74%)	35 (92.11%)	192 (84.21%)		
8. I understand that 12 months of unprotected intercourse is required for diagnosis in	Yes	28 (40.58%)	16 (35.56%)	47 (61.84%)	34 (89.47%)	125 (54.82%)	32.330	<0.001*
	No	41 (59.42%)	29 (64.44%)	29 (38.16%)	4 (10.53%)	103 (45.18%)		

individuals with infertility.								
9. In an approach to infertile couples, psychosocial support is necessary alongside medical treatment.	Yes	14 (20.29%)	30 (66.67%)	75 (98.68%)	38 (100.00%)	157 (68.86%)	124.721	<0.001*
	No	55 (79.71%)	15 (33.33%)	1 (1.32%)	-	71 (31.14%)		
10. An embryo is formed by the fusion of male and female reproductive cells.	Yes	55 (79.71%)	16 (35.56%)	73 (96.05%)	37 (97.37%)	181 (79.39%)	73.241	<0.001*
	No	14 (20.29%)	29 (64.44%)	3 (3.95%)	1 (2.63%)	47 (20.61%)		
11. Staying up-to-date with current technological advancements in infertility treatment contributes to my professional development.	Yes	42 (60.87%)	30 (66.67%)	72 (94.74%)	36 (94.74%)	180 (78.95%)	34.751	<0.001*
	No	27 (39.13%)	15 (33.33%)	4 (5.26%)	2 (5.26%)	48 (21.05%)		
12. When approaching an individual diagnosed with infertility, I consider the risk of stigma (social discrimination).	Yes	41 (59.42%)	30 (66.67%)	65 (85.53%)	35 (92.11%)	171 (75.00%)	21.020	<0.001*
	No	28 (40.58%)	15 (33.33%)	11 (14.47%)	3 (7.89%)	57 (25.00%)		

n; frequency, %; percent, χ^2 ; chi-square test, * $p < 0.05$

Table 8 presents the Attitude Toward Infertility Scale scores of students in basic medical sciences, clinical medicine, midwifery, and nursing, together with between-group comparisons. The highest attitude score was observed among students in basic medical sciences, whereas the lowest was recorded among midwifery students. Attitude scores differed significantly among the four groups ($H=115.337$, $p < 0.001^*$). Pairwise comparisons revealed statistically significant differences between midwifery and nursing ($p=0.008^*$), midwifery and clinical medicine ($p < 0.001^*$), midwifery and basic medicine ($p < 0.001^*$), nursing and clinical medicine ($p < 0.001^*$), and nursing and basic medicine ($p < 0.001$). A Kruskal-Wallis test revealed a statistically significant difference in infertility attitudes among the four departments ($H=115.337$, $p < 0.001$), indicating a large effect size ($\eta^2=0.508$). This large effect further highlights the clinical and practical significance of educational background for attitudes toward infertility.

Table 8. Comparison of Attitude Toward Infertility Scale scores among students in basic medical sciences, clinical medicine, midwifery, and nursing.

Variable	Group	Mean $\pm$ sd	M (Min - Max)	H	p	Effect size (η^2)
Attitudes Towards Infertility	Midwifery	35.72 $\pm$ 3.17	36(28-41)	115.337	<0.001*	0.508
	Nursing	38.24 $\pm$ 3.77	38(32-46)			
	Basic Medical Sciences	47.84 $\pm$ 7.57	48(20-60)			
	Clinical Medicine Sciences	47.74 $\pm$ 7.7	48(32-60)			

Sd; standard deviation, M; Median, H; Kruskal Wallis test, *p<0.05

Discussion

The present study compares the infertility-related knowledge and attitudes of medical students with those of midwifery and nursing students in the Faculty of Health Sciences. The findings indicate that infertility awareness extends beyond reproductive health or obstetrics education to include basic medical sciences, particularly embryology. Medical students had significantly higher attitude scores toward infertility than students in the Faculty of Health Sciences. These findings suggest that addressing infertility not only as a social or psychological condition but also as a biological process related to gametogenesis, fertilization, implantation, embryonic development, and assisted reproductive procedures may strengthen attitudes.

Students who had received embryology education had substantially higher attitude scores than those who had not received embryology instruction. This finding reinforces the view that embryology provides a clinical foundation for understanding infertility rather than being separate from clinical practice. However, despite its continued clinical relevance in areas such as obstetrics, gynecology, pediatrics, genetic counseling, and assisted reproductive technologies^{2,3}, studies have indicated that fewer hours of embryology are allocated in current medical curricula. Recent research among medical students has shown that they consider embryology clinically valuable but believe it should be supplemented with clinical context because the subject is perceived as difficult and abstract^{1,4}. Therefore, the present results suggest that, in addition to maintaining the importance of embryology in medical education, it should also be addressed more systematically in health sciences curricula.

Many believe that embryology knowledge unrelated to clinical practice has a limited impact on fostering lasting awareness among students. Therefore, a teaching model based on spiral and vertical integration between the basic and clinical sciences is recommended^{3,14}. The attitude scores of basic medical and clinical medical students in

our study were very similar. The mean attitude score was 47.84 ± 7.57 among basic medical students and 47.74 ± 7.70 among clinical medical students. This finding suggests that education in basic medical sciences and embryology during the first three years of medical school provides a positive foundation for developing favorable attitudes toward infertility. However, the transition to obstetrics and gynecology internships or clinical practice did not provide sufficient vertical integration to further promote this attitude. Therefore, theoretical knowledge provided during the preclinical period may not be fully adequate. Integrating clinical cases related to embryological knowledge, the evaluation of infertile couples, the application of assisted reproductive techniques, and ethical and psychosocial aspects into the preclinical period could positively affect these outcomes.

The lower attitude scores among midwifery and nursing students than among medical students suggest that embryological and laboratory-based mechanisms receive insufficient coverage because infertility is addressed more often under the headings of childbirth, reproductive health, or family planning in health sciences education. Dönmez and Emül (2021)⁸ found that nursing students' knowledge and attitudes toward infertility were generally favorable, but these levels were affected by characteristics such as year of study, gender, location, and family history of infertility. Additionally, Çakır et al. (2020)⁷ reported that although final-year students' attitudes toward infertility were generally positive, there was still room for improvement, particularly among midwifery and nursing students. They reported that final-year nursing students had higher attitude scores toward infertility than final-year midwifery students. The main curriculum-based explanation for this difference is that midwifery students have more frequent encounters with infertile individuals in gynecology and obstetrics departments and in vitro fertilization (IVF) centers during their education and clinical training. Although infertility is often covered within a narrower theoretical timeframe in the nursing curriculum, the opportunity for midwifery students to communicate directly with and provide healthcare to this patient population has a direct positive effect on their views⁷. The lowest attitude score in the midwifery group in this study indicates that, although midwifery students are likely to encounter infertile couples in clinical settings in their future professions, they may need more robust curricular support addressing infertility from embryological, clinical, and psychosocial perspectives.

One study reported that the attitudes of nursing, midwifery, and nutrition/dietetics students toward infertility differed according to their department and that the attitude scores of health sciences students were higher than those previously reported in the literature¹⁵. In our study, medical students had higher attitude scores than health sciences students. This disparity shows that health sciences students are not a homogeneous group and that their attitude levels should be examined according to factors such as department, year of study, personal contact with infertility, and embryology instruction.

Regarding the knowledge questions, the responses suggest that differences in attitude scores reflect more than a generally positive approach; they also reflect actual differences in specific knowledge areas. Significant differences were found for 11 of the 12 knowledge

questions between medical and health sciences students, suggesting education-related differences in fundamental areas such as understanding infertility as a disease, recognizing that treatment does not guarantee a definitive result, knowing the 12-month unprotected-intercourse criterion for diagnosis, recognizing the need for psychosocial support, and understanding the biological formation of embryos. The substantial differences across all knowledge questions in the comparison of the four groups show that basic medical sciences, clinical medicine, midwifery, and nursing programs are not uniform in terms of infertility knowledge. These findings indicate that a single course or clinical internship cannot adequately cover infertility education. Horizontal and vertical curriculum components, including basic biology, clinical decision-making, ethics, psychosocial support, and stigma awareness, are needed.

One of the study's main contributions is the analysis based on whether students had received embryology instruction. Statistically significant differences were found for 11 of the 12 knowledge questions between students who had and had not received embryology education. Students who had received embryology education provided more informed responses, particularly regarding infertility as a condition requiring treatment, the fact that IVF and insemination are not definitive solutions, diagnostic criteria, the need for psychosocial support, embryo formation, and the contribution of staying up to date with current technological developments to professional development. The findings suggest that embryology education may contribute to improved infertility awareness and more positive attitudes toward patient-centered infertility care. A bibliometric analysis of the intersection of midwifery, histology, and embryology by Çadırcı et al. (2026)⁵ noted that basic sciences reinforce pregnancy, fetal development, and evidence-based decision-making processes in midwifery education. The present study provides empirical support for this inference through students' attitudes and knowledge levels.

Mukhtar et al. (2023)² state that embryology education in medical school curricula should be integrated with histology during the preclinical period or taught independently. It includes cellular, molecular, and morphological details from gametogenesis to implantation and from morphogenesis to anomalies in early embryonic development. Our findings indicate that knowledge gained through embryology education is positively associated with attitudes toward reproductive health and infertility.

The findings of this study indicate a structural divergence in attitudes toward infertility between students in the Faculty of Medicine and those in the Faculty of Health Sciences (midwifery and nursing), all of whom are future health professionals. The high proportion of female students in the midwifery and nursing programs may also influence attitudes toward infertility. Studies have shown that female gender and professional orientation toward reproductive health disciplines are closely associated with the development of empathy toward couples facing infertility and a reduction in societal stigma¹⁶. The more balanced gender distribution in medical schools and the holistic approach to patients in clinical settings highlight the need for greater emphasis on empathy and stigma-related course content from the preclinical period onward.

Embryology education may improve biological and clinical awareness but may not be sufficient to change the societal stigma, social pressure, and psychological burden associated with infertility. Infertility is described as a life crisis with medical, psychological, and social consequences for couples; during treatment, feelings of guilt, stigma, deterioration of partner relationships, social isolation, and treatment discontinuation may occur¹⁷. Therefore, educational programs should incorporate psychological care, communication skills, ethical counseling, and anti-stigma training alongside embryology instruction. The results show that psychosocial support is as important as medical treatment when caring for individuals experiencing infertility, indicating that future health professionals should be equipped not only with biomedical knowledge but also with patient-centered communication skills and cultural sensitivity.

According to the literature, understanding of infertility is influenced by personal or familial experiences and lived realities^{8,18}.

Conclusion and Recommendations

A three-level curriculum framework for infertility education may positively influence the training of healthcare workers. The first phase should comprise the embryological foundations of gametogenesis, fertilization, implantation, embryonic development, congenital anomalies, and assisted reproductive techniques and should be organized and taught during the early years of medical and health sciences education. During the second, clinical phase, case-based learning should be integrated with training in assisted reproductive technology centers, obstetrics and gynecology, reproductive endocrinology, andrology, urology, genetic counseling, and embryology laboratories. In the third stage, communication with infertile couples, stigma, ethical decision-making, psychosocial support, and cultural sensitivity should be included among the core competencies common to all programs. This model could facilitate the transfer of preclinical knowledge to clinical awareness, strengthen the role of health sciences students in infertility care, and reinforce a patient-centered approach among all future health professionals.

In conclusion, the findings suggest that embryology education is associated with greater infertility knowledge and more positive attitudes among future healthcare professionals. The similarly high attitude scores of preclinical and clinical medical students are consistent with an association between early embryology education and positive attitudes; however, these findings also demonstrate the need to translate this knowledge further into patient-centered and practical skills in assisted reproductive technology centers during the clinical period. The lower attitude scores among midwifery and nursing students indicate that content related to embryology, infertility, and assisted reproductive technologies should be strengthened in a more systematic and clinically integrated manner in health sciences curricula, including psychosocial aspects. The results indicate that an obstetrics course alone may not be sufficient for infertility education; an integrated, stigma-sensitive teaching strategy that includes embryology as well as clinical and laboratory procedures is needed for future physicians, midwives, and nurses.

Study Limitations

This study has several limitations. First, its cross-sectional design precludes causal inference. Second, because participants were recruited using snowball sampling, selection bias cannot be excluded and the findings may not be fully generalizable to all medical and health sciences students. Third, all data were collected from a single institution, limiting the generalizability of the findings. Finally, knowledge and attitudes were assessed through self-reported questionnaires, which may be influenced by response bias. Future studies employing multivariable regression analyses are warranted to determine the independent contribution of embryology education after adjustment for potential confounding variables.

Conflict of Interest: The authors declare that they have no conflict of interest.

Financial Disclosure: This study has not been financed by any institutional organization.

Artificial Intelligence Assistance Statement: AI-assisted tools were used exclusively for language editing, literature review support, and improving manuscript readability. The authors independently verified all content and accept full responsibility for the manuscript.

REFERENCES

1. Opare-Asamoah K, Alhassan ZS. Medical students' attitudes, perceptions and future career interests towards embryology as a course at a public university in Ghana: A cross-sectional study. *BMC Medical Education*. 2025;25(1):900.
2. Mukhtar SF, Asari MA, Kasim F, et al. Relevancy of embryology in modern medical curriculum. *Education in Medicine Journal*. 2023;15(4):133-137. doi: 10.21315/eimj2023.15.4.10
3. Scott KM, Charles AR, Holland AJ. Clinical embryology teaching: Is it relevant anymore? *ANZ Journal of Surgery*. 2013;83(10):709-712.
4. Sume BW. Medical students' attitude and perception towards embryology course at Debre Markos University, Ethiopia. *Advances in Medical Education and Practice*. 2022;13:789-796.
5. Çadırcı C, Alasoy Ö, Kılıç KD. Bibliometric analysis at the intersection of midwifery, histology, and embryology. *Medical Records-International Medical Journal*. 2026;1(1):1754071.

6. Siyez DM, Esen E, Baran B, Seymenler S, Kağnıcı DY, Siyez E. Development of the Attitude toward Infertility Scale (ATIS): Validity and reliability study. *Cukurova Medical Journal*. 2018;43(1):173-180.
7. Çakır D, Dağlar G, Bilgiç D. Senior midwifery and nursing students' attitudes towards infertility. *Balikesir Journal of Health Sciences*. 2020;9(2):109-114.
8. Dönmez C, Emül TG. The knowledge and attitudes of nursing students infertility and determination of factors affecting these variables. *Ordu University Journal of Nursing Studies*. 2021;4(3):375-381.
9. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
10. Faul F, Erdfelder E, Lang AG. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*. 2009;41(4):1149-1160.
11. All European Academies. The European Code of Conduct for Research Integrity. ALLEA. <https://allea.org/wp-content/uploads/2023/12/The-European-Code-of-Conduct-2023-TR.pdf> Published 2023 (Accessed: June 20, 2026:6-12)
12. The British Psychological Society. Ethics Guidelines for Internet-Mediated Research. The British Psychological Society. https://explore.bps.org.uk/binary/bpsworks/64374754e0c1dd30/5a757d7c2d39a9837foeedec1b9ba28fa5e9e38f0bffa9950b678ab727803959/rep155_2021.pdf Published 2021 (Accessed: June 20, 2026:6-22)
13. Ishtiaq M. Book review: Creswell JW. Research Design: Qualitative, Quantitative and Mixed Methods Approaches. 4th ed. English Language Teaching. 2019;12(5):40-41. doi:10.5539/elt.v12n5p40.
14. Md Nawi F, Hadie SNH, Asari MA, Mat Nawi NF, Shamsuddin SA, Mohd Amin MSI. The relevance of clinical applied embryology knowledge in the preclinical undergraduate medical students: A scoping review protocol. *Education in Medicine Journal*. 2025;17(1):185-193.
15. Bayram Değer V. Faculty of health sciences students' attitudes towards infertility and their opinions towards assisted reproductive techniques. *Akdeniz Tıp Dergisi*. 2025;11(1):39-48.
16. Kizilkaya Beji N, Murat M. University students' attitudes toward gender roles and infertility: A descriptive and correlational study. *Perspect Psychiatr Care*. 2022;58(4):2601-2611.

17. Dikmen R, Aydın Eİ, Şahin S, Kaplan S. İnfertilite tedavisi başarısız olan hastanın Joyce Travelbee'nin insan insana ilişki modeline göre incelenmesi: Olgu sunumu. *İzmir Demokrasi Üniversitesi Sağlık Bilimleri Dergisi*. 2024;7(2):191-204.
18. Şenoymak İ, Tural E, Tuzcular Vural EZ, Taşkın Eğici M. Exploring attitudes towards infertility: Insights from a primary healthcare setting. *Journal of Medicine and Palliative Care*. 2024;5(4):193-197.

Association between Health Information Obtained via Social Media and Eating Attitudes: A Descriptive and Correlational Study

Halil İbrahim BİLKAY*, Esra ÜNAL**, Ayşenur DEMİR KÜÇÜKKÖSELER***

Abstract

Aim: Social media has become an important source of health information, shaping individuals' eating attitudes and behaviours. This study aimed to investigate the potential relationship of seeking health information through social media and eating attitudes.

Method: This descriptive and correlational study was conducted with 316 individuals aged 18 years and above through an online questionnaire. Data were collected using the Sociodemographic Information Form, the Eating Attitudes Test-26, and the Health Information Seeking and Verification Scale in Digital Media. Statistical analyses included descriptive statistics, correlation analysis, the Mann–Whitney U test, the Kruskal–Wallis test, and multiple linear regression analysis.

Results: The findings indicated that women had higher disordered eating scores compared to men, and that increased dieting frequency was associated with more negative eating attitudes. A positive relationship was identified between the implementation of health-related content obtained from social media and eating attitudes, whereas digital verification behaviors were specifically associated with restrictive eating patterns. Regression analysis revealed that only gender and dieting frequency significantly predicted eating attitudes, while digital health information-seeking and the application of social media suggestions were not found to exert a direct significant effect.

Conclusion: The findings suggest that individuals' digital health information-seeking behaviors may exert indirect effects on their eating attitudes. Therefore, when evaluating eating attitudes, health professionals should consider gender, dieting behaviors, and digital media interactions. In addition, comprehensive interventions fostering media literacy and body image awareness should be developed.

Keywords: Health knowledge, social media, eating behavior, attitude, body image.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 28.09.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1792718>

* Asst. Prof., KTO Karatay University, Faculty of Health Sciences, Department of Nursing, Konya, Türkiye.

E-mail: halil.bilkay@karatay.edu.tr [ORCID https://orcid.org/0000-0002-8231-960X](https://orcid.org/0000-0002-8231-960X)

** Res. Asst., KTO Karatay University, Faculty of Health Sciences, Department of Nursing, Konya, Türkiye.

E-mail: esra.unal@karatay.edu.tr [ORCID https://orcid.org/0000-0002-7588-9444](https://orcid.org/0000-0002-7588-9444)

*** Res. Asst., KTO Karatay University, Faculty of Health Sciences, Department of Nursing, Konya, Türkiye.

E-mail: aysenur.demir@karatay.edu.tr [ORCID https://orcid.org/0000-0002-0514-4957](https://orcid.org/0000-0002-0514-4957)

ETHICAL STATEMENT: Ethical approval was obtained from the KTO Karatay University Non-Pharmaceutical and Non-Medical Device Research Ethics Committee (Date: 08.05.2025; Decision No: 2025/031), and written permissions were secured from the authors of the scales used in the research. Informed consent was obtained from participants at the beginning of the study using the Informed Voluntary Consent Form.

Sosyal Medya Aracılığıyla Elde Edilen Sağlık Bilgilerinin Yeme Tutumları Arasındaki İlişki: Tanımlayıcı ve İlişki Arayıcı Bir Çalışma

Öz

Amaç: Sosyal medya, önemli bir sağlık bilgisi kaynağı haline gelmiş olup bireylerin yeme tutumlarını ve davranışlarını şekillendirmektedir. Bu çalışma, sosyal medya aracılığıyla sağlık bilgisi arama ile yeme tutumları arasındaki potansiyel ilişkiyi araştırmayı amaçlamıştır.

Yöntem: Tanımlayıcı ve ilişki arayıcı desende yürütülen araştırma, 18 yaş ve üzerindeki 316 birey ile çevrimiçi anket yoluyla gerçekleştirilmiştir. Veriler Sosyodemografik Bilgi Formu, Yeme Tutum Testi-26 ve Dijital Ortamlarda Sağlık Bilgisi Arama ve Doğrulama Ölçeği kullanılarak toplanmıştır. Veriler, tanımlayıcı istatistikler, korelasyon analizi, Mann-Whitney U testi, Kruskal-Wallis testi ve çoklu doğrusal regresyon analizi ile değerlendirilmiştir.

Bulgular: Kadınların, erkeklere kıyasla daha yüksek yeme bozukluğu puanlarına sahip olduğu ve diyet yapma sıklığındaki artışın daha olumsuz yeme tutumları ile ilişkili olduğu saptanmıştır. Sosyal medyadan elde edilen sağlık içeriklerini uygulamanın yeme tutumları ile pozitif yönde ilişkili olduğu, dijital doğrulama davranışlarının ise özellikle kısıtlayıcı yeme davranışlarıyla ilişkili olduğu belirlenmiştir. Regresyon analizine göre yalnızca cinsiyet ve diyet yapma sıklığı yeme tutumlarını anlamlı düzeyde yordarken, dijital sağlık bilgisi arama ve sosyal medya önerilerini uygulama doğrudan anlamlı bir etki göstermemiştir.

Sonuç: Bulgular, bireylerin dijital sağlık bilgisi arama davranışlarının yeme tutumları üzerinde dolaylı etkiler oluşturabileceğini göstermektedir. Bu doğrultuda sağlık profesyonelleri, yeme tutumlarını değerlendirirken cinsiyet, diyet yapma davranışları ve dijital medya etkileşimlerini dikkate almalı; medya okuryazarlığını ve beden algısı farkındalığını geliştirmeye yönelik kapsamlı müdahaleler geliştirmelidir.

Anahtar Sözcükler: Sağlık bilgisi, sosyal medya, yeme davranışı, tutum, beden algısı.

Introduction

Individuals' eating attitudes are increasingly shaped by online content as digital platforms become major sources of health information. In this process, individuals obtain information not only through traditional media tools but also via the internet and social media platforms¹. This transformation has made digital platforms an important source of information, particularly in areas such as health, nutrition, and lifestyle, which directly affect individuals' daily lives^{2,3}. Indeed, studies indicate that people use social media networks extensively to obtain information on nutrition and health, and that such use has been increasing day by day⁴⁻⁶.

Social media not only serves as a tool for individuals to obtain information about nutrition and health but also plays an active role in shaping attitudes and behaviors. Content shared on these platforms can directly influence individuals' dietary preferences, food choices, and overall eating habits⁷. The dissemination of diet recommendations and popular nutrition trends by social media content creators significantly affects individuals' food selections^{2,8}. When accurate and reliable information is shared, social media can also contribute to enhancing individuals' awareness of healthy eating⁹. In this context, social media is considered to function as a stimulus that encourages individuals to adopt healthier eating habits. Indeed, a study by

Sipahi and Demirel reported that individuals increased their water consumption and reduced their intake of processed foods as a result of exposure to nutrition-related posts on social media¹⁰. On the other hand, it has also been emphasized that incorrect or incomplete information on social media can have negative effects on individuals' eating attitudes and behaviors¹¹. International studies have reported that social media use is associated with unhealthy eating habits among young people, such as skipping breakfast, consuming junk food, and preferring unhealthy foods. Similarly, a systematic review concluded that the time spent on social media is linked to eating disorders¹². Based on these findings, it can be stated that health-related information on social media may influence individuals' eating attitudes and behaviors both positively and negatively. These results highlight the need for updated research on this topic.

Building on this background, the present study was conducted to examine the impact of obtaining information via social media on individuals' eating attitudes and behaviors. Although previous studies have explored the relationship between social media use and dietary behaviors, there remains a need for more comprehensive evidence focusing specifically on how health information obtained through these platforms shapes eating attitudes. This is particularly important given the dual nature of social media as both a source of accurate health information and a channel for misinformation. By addressing this gap, the findings are expected to contribute to the literature by offering evidence that may guide healthcare professionals in developing effective interventions to improve health literacy and promote healthy eating behaviors. This study aimed to investigate the relationship of seeking health information through social media and eating attitudes.

Material and Methods

Design

This study was designed as a descriptive and correlational research.

Variables and Research Questions

In line with the aim of the study, the dependent variable was the mean total score of the Eating Attitudes Test-26 (EAT-26), while the independent variables included participants' sociodemographic characteristics and the mean total score of the Health Information Seeking and Verification Scale in Digital Environments.

Research Questions

- What are individuals' levels of health information seeking and verification in digital environments?
- What are individuals' levels of eating attitudes?
- Is there a significant relationship between individuals' health information seeking and verification in digital environments and their eating attitudes?

- Do individuals' health information seeking and verification levels in digital environments affect their eating attitudes?

Population and Sample

The population of the study consisted of individuals aged 18 years and older. The sample size was calculated based on the correlation coefficient reported for the Eating Attitudes Scale in a study by Koç Özkan et al. ($r=0.18$; $p=0.004$), using 90% statistical power and an effect size of 0.30, resulting in a minimum sample of 316 participants¹³. Accordingly, the data collection process was concluded once the target sample size was reached. A non-probability sampling method, specifically convenience sampling, was used to select participants for the study.

Inclusion and Exclusion Criteria

Individuals aged 18 years and older who were able to speak, read, and write Turkish, had at least one active social media account (*Instagram, Whatsapp, Facebook etc.*) in the past three months, and voluntarily agreed to participate in the study were included. Individuals who did not provide voluntary consent were excluded from the study.

Data Collection Instruments

During the data collection process, the Sociodemographic Information Form, the Health Information Seeking and Verification Scale in Digital Environments, and the Short Form of the Eating Attitudes Test (EAT-26) were used.

The sociodemographic information form: The form was developed based on the literature and includes 16 items designed to determine participants' sociodemographic characteristics as well as social media and eating habits^{2-4,8,10}. The form collected information on age, gender, marital status, educational level, economic status, height, weight, perceived general health status, history of previous eating disorder diagnosis, frequency of dieting, consulting a dietitian or nutritionist, number of daily meals, daily social media usage, social media platforms used for accessing health and nutrition information, trusted social media content, the level of trust in health information on social media, and the extent to which nutrition-related recommendations on social media were implemented.

The health information seeking and verification scale in digital environments: The form was developed by Çömlekçi and Bozkanat to evaluate individuals' behaviors in seeking health information from digital platforms and verifying this information¹⁴. The scale is a 10-item, 5-point Likert-type instrument whose validity and reliability have been tested. It consists of three subdimensions:

- ***Digital verification (Items 7–10):*** Measures participants' habits of verifying health information obtained from digital sources. Higher scores indicate more frequent verification behavior.

- **Web 1.0 and health information seeking (Items 1–3):** Reflects the level of health information acquisition from non-interactive sources (e.g., static websites).
- **Web 2.0 and digital health information seeking (Items 4–6):** Indicates the tendency to seek health information via social media platforms (e.g., Instagram, YouTube, Twitter).

Scores for each subdimension range from 1 to 5. There are no reverse-scored items on the scale. Subdimensions should be evaluated separately; analyzing all items together as a single total score is not recommended. The Cronbach's alpha reliability coefficient of the scale was 0.75 in the original study and 0.73 in the present study.

Short form of the eating attitudes test (EAT-26): EAT-26 is the Turkish adaptation of the Eating Attitudes Test developed by Garner et al. to assess individuals' eating behaviors, attitudes toward eating, and risk of eating disorders¹⁵. The Turkish version was adapted by Ergüney-Okumuş and Sertel-Berk¹⁶. The scale consists of 26 items and is structured as a 6-point Likert-type instrument. The first 25 items are scored from "Always = 3" to "Never = 0," while the 26th item is reverse-coded. The scale includes three subdimensions: *Restrictive Eating* (Items 5, 6, 7, 16, 17, 19, 23), *Eating Preoccupation* (Items 1, 2, 3, 4, 10, 11, 12, 14, 18, 21, 22), and *Social Pressure* (Items 8, 13, 15, 20). In the adaptation study, Items 9, 24, 25, and 26 were not included in any subdimension due to factor loadings and item analysis results. Total scores are calculated from all items, with a cutoff score of 20. Higher scores indicate a greater risk of disordered eating behaviors. Cronbach's alpha reliability coefficient of the scale was 0.84 in the original adaptation study and 0.79 in the present study.

Data Collection Procedure

In order to contribute to environmental sustainability, the data collection process was conducted entirely online. Accordingly, the instruments used in this study were adapted to an online survey format, and participants' responses were collected via Google Forms between May and June 2025. This approach aimed to reduce paper usage and contribute to lowering the carbon footprint. Prior to the main data collection, a pilot study was conducted with a group of 10 participants to test the clarity of the survey, its technical functionality, and the usability of the instruments. Based on the feedback obtained from the pilot study, no modifications were deemed necessary for the survey form. Data obtained from the pilot study were not included in the main analysis. The data collection continued until the predetermined sample size (316 participants) was reached. Once the minimum required number of participants was achieved, access to the survey was restricted to prevent additional responses, thereby ensuring systematic and controlled data collection.

Ethical Statement

Ethical approval was obtained from the KTO Karatay University Non-Pharmaceutical and Non-Medical Device Research Ethics Committee (Date: 08.05.2025; Decision No.:

2025/031), and written permissions were secured from the authors of the scales used in the research. Informed consent was obtained from participants at the beginning of the study using the Informed Voluntary Consent Form.

Data Analysis

IBM SPSS 25 software was used for the analysis of the study data. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were calculated to summarize the data. The normality of the data was assessed using the Kolmogorov–Smirnov test and Q-Q plots. The results indicated that the data for the scale score averages did not conform to a normal distribution. Therefore, the Mann–Whitney U test was used for comparisons between two groups, and the Kruskal–Wallis test was applied for comparisons among three or more groups. Relationships between age and body mass index (BMI) and the levels of eating attitudes and digital health information seeking and verification were evaluated using Spearman correlation analysis, taking into account the non-normal distribution of the data. Additionally, multiple regression analysis was conducted to examine the effects of sociodemographic variables and digital health information seeking and verification on eating attitude levels. A 95% confidence interval and a significance level of $p < 0.05$ were used for all analyses.

Results

The findings are presented in line with the study objectives, covering participants' sociodemographic characteristics, levels of digital health information seeking and verification, eating attitudes, and the relationships between these variables. Statistical analyses were conducted to examine differences and associations, and the results are summarized across four tables.

Table 1. Distribution of the mean total scores obtained from the EAT-26 according to some sociodemographic characteristics of the participants (n=316)

	Mean±SD			Min-Max	Test value p
Age	27.56±9.71			18-72	r: 0.038 p: 0.505
BMI (kg/m²)	24.23±4.55			15.96-43.75	r: 0.138 p: 0.014*
	n	%	Mean Rank	EAT-26 Total Score Mean±SD	Test value p
Gender					
Female	255	80.7	166.83	8.93±6.87	Z: -3.324
Male	61	19.3	123.66	5.90±4.25	p: 0.001**
Marital Status					
Married	98	31.0	162.69	8.78±6.99	Z: -0.549
Single	218	69.0	156.61	8.15±6.35	p: 0.583
Educational Status					
Primary school	27	8.5	171.57	9.15±7.07	KW: 0.744
High school	59	18.7	153.37	8.15±6.65	p: 0.689
University or higher	230	72.8	158.28	8.30±6.49	
Perceived Income					
Low	50	15.8	154.59	8.10±6.53	KW: 0.412

Moderate	245	77.5	160.13	8.42±6.55	p: 0.814
High	21	6.6	148.74	8.10±6.87	
Perceived General Health					
Poor	26	8.2	180.42	9.15±5.66	KW: 1.734
Fair	143	45.3	158.20	8.62±7.38	p: 0.420
Good	147	46.5	154.92	7.93±5.82	
Chronic Illness					
Yes	96	30.4	160.79	8.60±7.08	Z: -0.295
No	220	69.6	157.50	8.23±6.32	p: 0.768
Eating Disorder Diagnosis					
Yes	20	6.3	193.80	11.30±8.09	Z: -1.790
No	296	93.7	156.11	8.15±6.40	p: 0.073
Dieting Frequency					
Never	116	36.7	132.58	6.47±4.86	KW: 43.634
Occasionally	157	49.7	156.68	8.15±6.48	p: 0.000**
Frequently	29	9.2	216.12	12.17±7.07	
Continuously	14	4.4	274.25	18.21±6.97	
Receiving Professional Support					
Yes	101	32.0	181.07	10.14±7.89	Z: -3.018
No	215	68.0	147.90	7.50±5.64	p: 0.003**
Daily Meals					
1	7	2.2	167.71	9.00±6.58	KW: 3.702
2	144	45.6	167.70	8.68±6.11	p: 0.296
3	154	48.7	148.44	7.89±6.90	
4 or more	11	3.5	173.14	9.91±7.43	
Daily Social Media Use					
Less than 1 hour	24	7.6	166.38	8.54±6.12	KW: 1.549
1-3 hours	132	41.8	153.87	7.72±5.43	p: 0.671
4-6 hours	118	37.3	157.08	8.43±6.89	
6 hours or more	42	13.3	172.56	9.95±8.65	
Most Frequently Used Health/Nutrition Information Platform					
Instagram	196	62.0	155.09	8.24±6.78	KW: 1.703
Youtube	21	6.6	167.33	8.57±5.60	p: 0.945
Tiktok	8	0.6	156.94	6.88±2.74	
Twitter	5	0.3	151.50	7.00±3.67	
Facebook	4	0.3	177.00	10.25±8.99	
Whatsapp	47	19.0	171.48	9.60±7.73	
Other	35	11.1	154.11	7.43±4.51	
Trusted Content Sources					
Expert posts	262	82.9	157.79	8.32±6.59	KW: 4.095
Influencers	10	3.2	177.20	10.80±9.93	p: 0.536
Blog articles	4	1.3	102.63	5.00±5.59	
Academic articles	19	6.0	182.34	9.53±5.89	
Friends' recommendations	8	2.5	128.75	6.00±3.92	
Other	13	4.1	159.12	7.62±4.77	
Level of Trust					
Do not trust at all	27	8.5	157.52	7.41±4.22	KW: 0.147
Do not trust	58	18.4	155.51	7.93±5.95	p: 0.997
Neutral	175	55.4	159.11	8.30±6.38	
Trust	44	13.9	158.66	9.30±8.52	
Strongly trust	12	3.8	165.63	9.58±8.18	
Applying Social Media Recommendations					
Yes	93	29.4	180.61	9.88±7.15	Z: -2.786
No	223	70.6	149.28	7.70±6.19	p: 0.005**

BMI: body mass index, Z: Mann-Whitney U test, KW: Kruskal Wallis test, r: Spearman correlation test, SD: standard deviation, *:p<0.05; **:p<0.01.

The mean age of the participants was 27.56 ± 9.71 years, and the mean BMI was 24.23 ± 4.55 . The majority were female (80.7%), single (69%), and had a university or higher education level (72.8%). Most reported a moderate income level (77.5%) and perceived their general health as good (46.5%). The majority did not have any chronic illness (69.6%) or an eating disorder diagnosis (93.7%). About half of the participants (49.7%) reported dieting occasionally, 68% had not received support from a dietitian or nutritionist, and 48.7% consumed three meals per day. Daily social media use was 1–3 hours for 41.8% of participants, and 62% frequently obtained health and nutrition information from Instagram. Most participants trusted expert posts on health and nutrition (82.9%), 55.4% were undecided about the reliability of health information on social media, and 70.6% did not apply the diet or nutrition recommendations seen on social media (Table 1).

When EAT-26 total scores were examined according to participants' sociodemographic characteristics, significant differences were observed for gender, dieting frequency, professional support, and adherence to social media recommendations ($p < 0.05$). No significant differences were found for age, marital status, education level, perceived income, perceived general health, presence of illness or eating disorder diagnosis, number of daily meals, daily social media use, or preferred health information platform ($p > 0.05$). Correlation analysis indicated no significant relationship between age and EAT-26 total scores ($r = 0.038$; $p = 0.505$), while a weak positive significant correlation was found with BMI ($r = 0.138$; $p = 0.014$) (Table 1).

Table 2. Mean Scores of Participants on the EAT-26 and the Digital Health Information Seeking and Verification Scale, Total and Subdimensions (n=316)

	Number of Items (Min-Max)	Mean $\pm$ SD
Eating Attitudes Test-Short Form Total Score Mean	26 (0-44)	8.34$\pm$6.55
Restrictive Eating	7 (0-14)	1.93 $\pm$ 2.38
Eating Preoccupation	11 (0-20)	3.75 $\pm$ 4.37
Social Pressure	4 (0-8)	1.16 $\pm$ 1.69
Health Information Seeking and Verification Scale		
Digital Verification	4 (4-20)	11.75 $\pm$ 4.19
Web 1.0 Health Information Seeking	3 (3-14)	7.36 $\pm$ 2.42
Web 2.0/Digital Health Information Seeking	3 (3-15)	7.43 $\pm$ 2.66

The mean total score of EAT-26 was 8.34 ± 6.55 . Mean scores for the subscales were as follows: Restrictive Eating 1.93 ± 2.38 , Eating Preoccupation 3.75 ± 4.37 , and Social Pressure 1.16 ± 1.69 . For the Health Information Seeking and Verification Scale, mean scores were: Digital Verification 11.75 ± 4.19 , Web 1.0 Health Information Seeking 7.36 ± 2.42 , and Web 2.0/Digital Health Information Seeking 7.43 ± 2.66 (Table 2).

Table 3. The relationship between participants' EAT-26 total and subscale mean scores and the Digital Health Information Acquisition and Verification Scale subscale mean scores (n=316)

		EAT-26 Total	Restrictive Eating	Eating Preoccupati on	Social Pressu re	Digital Verificati on	Web 1.0	We b 2.0
EAT-26 Total	r	1.000						
	p							
Restrictive Eating	r	0.609	1.000					
	p	0.000**						
Eating Preoccupati on	r	0.747	0.181	1.000				
	p	0.000**	0.001**					
Social Pressure	r	0.447	0.295	0.112	1.000			
	p	0.000**	0.000**	0.046*				
Digital Verification	r	0.064	0.186	-0.052	0.032	1.000		
	p	0.255	0.001**	0.357	0.570			
Web 1.0	r	0.060	0.017	0.102	0.056	0.257	1.000	
	p	0.287	0.758	0.070	0.324	0.000**		
Web 2.0	r	0.093	0.080	0.129	0.044	0.092	0.433	1.000
	p	0.098	0.154	0.022*	0.435	0.101	0.000**	

r: Spearman correlation test, *:p<0.05; **:p<0.01.

No significant correlation was found between the EAT-26 total score and the subscales of Digital Verification, Web 1.0 Health Information Seeking, and Web 2.0/Digital Health Information Seeking ($p>0.05$). However, a weak positive correlation was observed between the Restrictive Eating subscale and Digital Verification ($r=0.186$; $p=0.001$), as well as between the Eating Preoccupation subscale and Web 2.0/Digital Health Information Seeking ($r=0.129$; $p=0.022$) (Table 3).

Table 4. Effects of Digital Verification, Web 1.0, Web 2.0 Use, and sociodemographic variables on the total score of the EAT-26 ($n=316$)

Eating Attitude Level	B	Std. Error	Z B	t	p	%95 Confidence Interval for β	
Eating Attitude						Lower Limit	Upper Limit
Model							
(Constant)	0.884	3.766		0.235	0.815	-6.527	8.294
Digital Verification	0.042	0.085	0.027	0.495	0.621	-0.125	0.209
Web 1.0	0.153	0.165	0.057	0.925	0.356	-0.172	0.477
Web 2.0	0.241	0.145	0.098	1.657	0.098	-0.045	0.527
BMI	0.095	0.086	0.066	1.097	0.274	-0.075	0.265
Age	-2.227	0.951	-0.134	-2.341	0.020	-4.099	-0.355
Dieting Frequency	2.758	0.504	0.327	5.477	0.000	1.767	3.749
Professional Support	-0.010	0.848	-0.001	-0.012	0.991	-1.679	1.659
Applying Social Media Recommendations	-0.337	0.814	-0.023	-0.414	0.679	-1.938	1.265

Model Significance $F=8.737$; $p=0.00$; $R^2=0.185$; Adjusted $R^2=0.164$, BMI: body mass index, β : Regression coefficient, Se: Standard error, $z\beta$: Standardized regression coefficient, R^2 : Coefficient of determination. ($p<0.05$).

The multiple linear regression model examining factors affecting the EAT-26 total score was statistically significant and met the assumptions of regression analysis ($F=8.737$; $p<0.001$). Among the variables included, only gender and dieting were significant predictors of eating attitudes ($p<0.05$). Digital Verification, Web 1.0, Web 2.0, BMI, professional support, and adherence to social media recommendations were not significant predictors ($p>0.05$). The model explained 18% of the variance in EAT-26 total scores ($R^2=0.185$). Specifically, a one-unit increase in gender (female=1, male=2) was associated with a 2.227-point decrease in eating attitude scores, while a one-unit increase in dieting frequency corresponded to a 2.758-point increase (Table 4).

Discussion

The findings indicate that digital information-seeking, gender, dieting frequency, and social media use are associated with eating attitudes. One of the most notable findings is that female participants exhibited significantly higher disordered eating scores compared to male participants. This finding highlights the potential role of gender-related sociocultural factors in body image and eating behaviors. Social pressures on women to maintain a slimmer and thinner body can lead to stricter, more restrictive, and controlling eating behaviors¹⁷. Previous studies have also indicated that women experience greater body image concerns than men, which in turn negatively affect their eating attitudes^{18,19}. Furthermore, the higher prevalence of psychiatric comorbidities among women suggests that eating disorder psychopathology should be examined from a gender-based perspective. Lydecker and Grilo reported that female participants exhibited significantly higher levels of eating disorder symptoms and depressive symptoms compared to males²⁰. These findings underscore the need to investigate women's eating attitudes within the context of mental health.

Another key finding of the study is the significant positive relationship between dieting frequency and eating attitudes. As the frequency of dieting increased, participants' eating attitude scores also increased. This suggests that dieting practices may be associated with not only for physical health but also for psychological well-being and eating behaviors. This finding aligns with previous studies conducted in clinical samples, which reported that certain dieting practices are associated with eating disorder psychopathology²¹⁻²³. Fan et al. specifically noted that vegetarian and paleo diets may increase the risk of eating disorders in relation to body image and sociocultural ideals of the body²³. In this context, dieting behaviors intensified by social pressures may be associated with negative eating attitudes.

The study findings also indicate that diet- and health-related content on social media platforms can influence individuals' eating attitudes. Participants who applied the recommendations encountered on social media exhibited higher disordered eating scores, suggesting that social media can directly shape eating behaviors. Previous studies similarly report that exposure to social media content—particularly those related to weight loss, ideal body, and dieting—increases body dissatisfaction and the risk of eating disorders²⁴⁻²⁶. Sanzari et al. demonstrated that such content is associated with lower body appreciation, negative appearance evaluation, and binge eating behaviors²⁴. Similarly, Kim and Mackert reported a significant association between social media use and binge eating²⁷. These findings suggest that individuals tend to apply digital content without critical evaluation, which may trigger unhealthy eating behaviors. Therefore, there is a need for intervention studies focused on eating behaviors that consider body image, social pressure, and digital media factors in an integrated manner.

Another notable finding is the positive relationship between restrictive eating behaviors and the tendency to digitally verify information. Participants' inclination to verify the accuracy of information in digital environments appears to be associated with more controlled and restrictive attitudes toward eating. This tendency may be linked to

increased monitoring of eating behaviors when individuals experience body dissatisfaction. Zaharia and Gonça suggest that this behavior could be related to efforts to reduce the discrepancy between one's actual and ideal body²⁸. Moreover, several studies have highlighted that beauty standards promoted on social media negatively affect body image, trigger eating disorder symptoms, and increase the need for interventions that support positive body image^{28,29}.

The findings from the regression analysis revealed that only gender and dieting frequency significantly predicted eating attitudes. In contrast, variables such as digital health information-seeking behavior, adherence to social media recommendations, and the tendency to verify information digitally did not emerge as significant predictors. This suggests that the impact of social media-related behaviors on eating attitudes may occur indirectly rather than directly. This finding is consistent with and supports previous research proposing that psychological factors such as body image, self-esteem, and social comparison may mediate the relationship between social media use and eating attitudes.

The multiple linear regression model was statistically significant and explained 18% of the variance in EAT-26 scores. Only gender and dieting frequency emerged as significant predictors, with higher scores observed among females and those with more frequent dieting. Other variables, including social media-related behaviors, were not significant predictors. Notably, although social media-related variables were not directly associated with eating attitudes in the regression model, their role should not be disregarded. These findings suggest that the relationship between social media use and eating attitudes may not be direct but could operate through indirect pathways involving psychological and behavioral factors. In line with previous research, variables such as body image, self-esteem, and social comparison may play a mediating role in this relationship. However, since such variables were not included in the present study and mediation analysis was not conducted, this interpretation should be considered cautiously and warrants further investigation in future research.

In general, the findings highlight the need for health professionals to develop awareness regarding how individuals evaluate information and recommendations encountered on social media. Critically assessing social media-based content that may influence eating attitudes can support individuals in managing their dietary behaviors more healthily. Furthermore, nutrition counselling is recommended to adopt a multidisciplinary approach that addresses not only physical health but also psychological well-being, body image, and digital media use habits.

In this context, implementing targeted interventions aimed at enhancing media literacy and promoting body positivity may contribute to reducing the risk of eating disorders²⁶.

Limitations and Strengths

This study has several limitations. First, the data were collected via an online platform using self-report measures, which may have introduced bias, as participants may have reported their eating attitudes, social media use, and digital health information-seeking

behaviors differently from their actual practices. Second, the cross-sectional design limits the ability to establish causal relationships between variables; therefore, the findings should be interpreted at a correlational level, and longitudinal studies are needed to better understand these relationships.

Third, the predominance of young adults in the sample restricts the generalizability of the findings to other age groups. Additionally, as the sample consisted of community-dwelling individuals without clinical diagnoses, the results cannot be directly generalized to clinical populations with diagnosed eating disorders.

Another important limitation is that social media use was assessed in a relatively limited manner, primarily in terms of general usage and behaviors. Variables such as the type of content consumed, purpose of use, and level of engagement were not examined, which may be important in understanding the relationship between social media and eating attitudes.

Furthermore, key psychological variables—such as body image, self-esteem, social comparison, and depression—were not included in the study. The absence of these variables limits a more comprehensive understanding of the mechanisms underlying the relationship between social media use and eating attitudes.

Despite these limitations, the study also has several strengths. It contributes to the literature by examining the association between digital health information-seeking via social media and eating attitudes from a multidimensional perspective. The use of psychometrically valid and reliable scales strengthens the internal validity of the findings. Additionally, the study highlights the possibility that the relationship between social media use and eating attitudes may operate through indirect pathways, providing a basis for future research, including studies using mediation models.

Conclusion

The findings indicate that digital information-seeking, gender, dieting frequency, and social media use are associated with eating attitudes. Women exhibited higher levels of problematic eating attitudes, highlighting the influence of societal pressures on body image, while frequent dieting was associated with an increased risk of disordered eating. Although following nutrition recommendations on social media and digital verification behaviors were not identified as direct predictors, these factors may still have indirect influences on eating attitudes.

These findings suggest that eating attitudes in the digital age are shaped not only by individual behaviors but also by broader psychosocial and digital factors. Therefore, healthcare professionals should consider these dimensions when evaluating dietary behaviors. In addition, interventions aimed at improving media literacy and promoting critical evaluation of online health information may help prevent negative eating outcomes. Future studies should incorporate psychological variables such as body image and self-esteem to better understand these relationships.

Ethical Compliance

Prior to initiating the study, ethical approval was obtained from the KTO Karatay University Non-Pharmaceutical and Non-Medical Device Research Ethics Committee (Date: 08.05.2025; Decision No.: 2025/031), and written permissions were secured from the authors of the scales used in the research. Informed consent was obtained from participants at the beginning of the study using the Informed Voluntary Consent Form. Participants were provided with detailed information about the study's purpose and the intended use of the data. Additionally, in accordance with the Declaration of Helsinki, ethical principles including "Respect for Human Dignity," "Respect for Autonomy," and "Confidentiality and Privacy Protection" were applied. This ensured that participants' ethical rights and safety were safeguarded and that the research process was conducted meticulously.

Conflict of Interest Statement

The authors declare no conflict of interest.

Funding

No financial support was received for this study.

Data Availability

Data will be made available upon request.

REFERENCES

1. Barış Ö. Geleneksel ve sosyal medya gündem uyumu incelemesi: Twitter, Fox TV ve ATV Ana Haber Bülten karşılaştırılması. *Erciyes İletişim Derg.* 2019;6(1):169-184.
2. Li J, Tang J, Liu X, Ma L. How do users adopt health information from social media? The narrative paradigm perspective. *Health Inf Manag J.* 2018;48(3):116-126.
3. Duran S, Çetinbaş A, Başaran T, Kara A, Elgün B, Keklik N. Üniversite öğrencilerinde stres ve sosyal medya kullanımının yeme davranışları üzerine etkisi. *Eurasian J Fam Med.* 2019;8(4):149-154. doi: 10.33880/ejfm.2019080402.
4. Ramachandran D, Kite J, Vassallo AJ, et al. Food trends and popular nutrition advice online: Implications for public health. *Online J Public Health Inform.* 2018;10(2):e62334.

5. Çapaş M, Çavdar M. Sosyal medyanın üniversite öğrencilerinin yeme tutum ve davranışlarına olan etkisi. *Sağlık Bilim Derg.* 2023;32(2):284-291.
6. Oral EA, Öztaşkın S. Yetişkinlerde sosyal medya kullanımının yeme bozukluğu ve beden algısı ile ilişkisi. *Baskent Univ Sağlık Bil Fak Derg.* 2024;9(1):86-100.
7. Patwardhan V, Mallya JSK, Kumar D. Influence of social media on young adults' food consumption behavior: Scale development. *Cogent Soc Sci.* 2024;10(1):2391016.
8. Cheng X, Lin SY, Wang K, et al. Healthfulness assessment of recipes shared on Pinterest: Natural language processing and content analysis. *J Med Internet Res.* 2021;23(4):e25757.
9. Yang Q. Are social networking sites making health behavior change interventions more effective? A meta-analytic review. *J Health Commun.* 2017;22(3):223-233.
10. Sipahi S, Demirel B. Sosyal medyadaki beslenme ile ilgili paylaşımların yetişkin bireylerin yeme tutum ve davranışlarına etkisi. *Beslenme Diyet Derg.* 2021;49(1):57-66.
11. Rounsefell K, Gibson S, McLean S, et al. Social media, body image and food choices in healthy young adults: A mixed methods systematic review. *Nutr Diet.* 2020;77(1):19-40.
12. Padín PF, González-Rodríguez R, Verde-Diego C, Vázquez-Pérez R. Social media and eating disorder psychopathology: A systematic review. *Cyberpsychol J Psychosoc Res Cyberspace.* 2021;15(3):6. doi: 10.5817/CP2021-3-6.
13. Koç Özkan TK, Erdemoğlu Ç, Turan İ, Özkan SA. Adölesanlarda premenstrual sendrom ile yeme tutumu arasındaki ilişki. *Gobeklitepe Med Sci J.* 2022;5(8):142-151.
14. Çömlekçi MF, Bozkanat E. İnfodemide dijital ortamda sağlık bilgisi edinme ve teyit davranışları. *Istanbul Univ J Sociol.* 2021;41(1):103-125.
15. Garner DM, Olmsted MP, Bohr Y, Garfinkel PE. The eating attitudes test: Psychometric features and clinical correlates. *Psychol Med.* 1982;12(4):871-878.
16. Ergüney-Okumuş FE, Sertel-Berk HÖ. Yeme Tutum Testi Kısa Formunun (YTT-26) üniversite örnekleminde Türkçeye uyarlanması ve psikometrik özelliklerinin değerlendirilmesi. *Stud Psychol.* 2020;40(1):57-78. doi: 10.26650/SP2019-0039.
17. Halbeisen G, Laskowski N, Brandt G, Waschescio U, Paslakis G. Eating disorders in men. *Dtsch Arztebl Int.* 2024;121(3):86-91. doi: 10.3238/arztebl.m2023.0246.

18. Núñez-Navarro A, Agüera Z, Krug I, et al. Do men with eating disorders differ from women in clinics, psychopathology and personality? *Eur Eat Disord Rev.* 2012;20(1):23-31.
19. Hayaki J, Free S. Positive and negative eating expectancies in disordered eating among women and men. *Eat Behav.* 2016;22:22-26. doi: 10.1016/j.eatbeh.2016.03.025.
20. Lydecker J, Grilo C. Comparing men and women with binge-eating disorder and co-morbid obesity. *Int J Eat Disord.* 2018;51(4):411-417. doi: 10.1002/eat.22847.
21. Norwood R, Cruwys T, Chachay VS, Sheffield J. The psychological characteristics of people consuming vegetarian, vegan, paleo, gluten free and weight loss dietary patterns. *Obes Sci Pract.* 2019;5(2):148-158. doi: 10.1002/osp4.325.
22. Shahan M, Jordan K, Siegfried N, Douglas C, Lawrence J. Eating disorder risk and severity as a function of following self-administered popular diets. *Curr Dev Nutr.* 2020;4(suppl 2):565. doi: 10.1093/cdn/nzaa046_065.
23. Fan J, Nagata J, Cuccolo K, Ganson K. Associations between dieting practices and eating disorder attitudes and behaviors: Results from the Canadian study of adolescent health behaviors. *Eat Behav.* 2024;54:101886. doi: 10.1016/j.eatbeh.2024.101886.
24. Sanzari C, Gorrell S, Anderson L, et al. The impact of social media use on body image and disordered eating behaviors: Content matters more than duration of exposure. *Eat Behav.* 2023;49:101722. doi: 10.1016/j.eatbeh.2023.101722.
25. Wu Y, Kemps E, Prichard I. Digging into digital buffets: A systematic review of eating-related social media content and its relationship with body image and eating behaviours. *Body Image.* 2024;48:101650. doi: 10.1016/j.bodyim.2023.101650.
26. Dopelt K, Houminer-Klepar N. The impact of social media on disordered eating: Insights from Israel. *Nutrients.* 2025;17(1):180. doi: 10.3390/nu17010180.
27. Kim BR, Mackert M. Social media use and binge eating: An integrative review. *Public Health Nurs.* 2022;39(5):1134-1141. doi: 10.1111/phn.13069.
28. Zaharia A, Gonța I. The healthy eating movement on social media and its psychological effects on body image. *Front Nutr.* 2024;11:1474729. doi: 10.3389/fnut.2024.1474729.
29. Wadhwa C, Thakker H, Kaushik V, et al. Study on assessing the evolution of nutritional choices through social media influence. *Evol Stud Imagin Cult.* 2024;8(2 suppl 2):860-869. doi: 10.70082/esiculture.vi.1084.

Screen Exposure, Circadian Rhythm, Sleep, Physical Activity, and Health Anxiety in University Students During Online Education

Sümeyye AKÇAY*, Mehmet Burak UYAROĞLU**, Gamze KOYUTÜRK***, Zuhale KUNDURACILAR****, Emre Serdar ATALAY*****, Burcu AKKURT*****

Abstract

Aim: This study aimed to examine the associations between screen exposure, sedentary behavior, circadian rhythm, sleep, physical activity, and health anxiety among university students during the online education period.

Method: A total of 130 healthy university students participated. Data on socio-demographic characteristics, sleep onset latency, wake-up times, nighttime light exposure, and screen time were collected. Participants also completed the Morningness-Eveningness Questionnaire, the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), the International Physical Activity Questionnaire (IPAQ), and the Short Health Anxiety Inventory.

Results: The sample included 101 females (78%) and 29 males (22%). Weak positive correlations were found between wake-up time and sleep onset latency, phone use and sleep duration, PSQI and several sleep parameters, ESS and phone use, and health anxiety with both PSQI and ESS. Weak negative correlations were observed between phone use and computer time, circadian rhythm and both sleep duration and phone use, and between circadian rhythm and PSQI and ESS. There was a moderate positive association observed between the ESS and PSQI scores.

Conclusion: The findings suggest that lifestyle changes associated with online education may be linked to alterations in students' circadian rhythm, sleep quality, and health anxiety. However, most associations were weak, indicating that these outcomes are likely influenced by multiple interacting factors.

Keywords: Digital device use, sleep quality, daytime sleepiness, sedentary lifestyle, student health.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 09.09.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1780968>

* Asst. Prof., Fenerbahçe University, Faculty of Health Sciences, Department of Occupational Therapy, İstanbul, Türkiye. E-mail: sumeyye.akcay@fbu.edu.tr [ORCID https://orcid.org/0000-0001-8951-6369](https://orcid.org/0000-0001-8951-6369)

** Asst. Prof., Fenerbahçe University, Vocational School of Health Sciences, Physiotherapy Program, İstanbul, Türkiye. E-mail: mehmet.uyaroglu@fbu.edu.tr [ORCID https://orcid.org/0000-0003-0300-1140](https://orcid.org/0000-0003-0300-1140)

*** Asst. Prof., İstanbul Topkapı University, Faculty of Health Sciences, Department of Occupational Therapy, İstanbul, Türkiye. E-mail: gamzekoyuturk@topkapi.edu.tr [ORCID https://orcid.org/0000-0002-7240-9425](https://orcid.org/0000-0002-7240-9425)

**** Prof., İstanbul Gelisim University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, İstanbul, Türkiye. E-mail: zkunduracilar@gelisim.edu.tr [ORCID https://orcid.org/0000-0002-1351-2967](https://orcid.org/0000-0002-1351-2967)

***** Asst. Prof., Sağlık Bilimleri University, Faculty of Gülhane Physiotherapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, İstanbul, Türkiye. E-mail: emreserdar.atalay@sbu.edu.tr [ORCID https://orcid.org/0000-0002-8249-8628](https://orcid.org/0000-0002-8249-8628)

***** Asst. Prof., Fenerbahçe University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, İstanbul, Türkiye. E-mail: burcu.akkurt@fbu.edu.tr [ORCID https://orcid.org/0000-0001-8394-9702](https://orcid.org/0000-0001-8394-9702)

ETHICAL STATEMENT: This study was carried out with the approval of the Ethics Committee of Sağlık Bilimleri University, dated 22/04/2022 and numbered 12/8. A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant.

Çevrim İçi Eğitim Döneminde Üniversite Öğrencilerinde Ekran Maruziyeti, Sirkadiyen Ritim, Uyku, Fiziksel Aktivite ve Sağlık Anksiyetesi

Öz

Amaç: Bu çalışma, çevrim içi eğitim döneminde üniversite öğrencilerinde ekran maruziyeti, sedanter davranış ile sirkadiyen ritim, uyku, fiziksel aktivite ve sağlık anksiyetesi arasındaki ilişkileri incelemeyi amaçladı.

Yöntem: Toplam 130 sağlıklı üniversite öğrencisi çalışmaya katıldı. Sosyo-demografik özellikler, uykuya dalma süresi, uyanma zamanları, gece ışık maruziyeti ve ekran süresi ile ilgili veriler toplandı. Katılımcılar ayrıca Sabahçılık-Akşamcılık Anketi, Pittsburgh Uyku Kalitesi İndeksi (PUKİ), Epworth Uykululuk Ölçeği (EUÖ), Uluslararası Fiziksel Aktivite Anketi (UFAA) ve Kısa Sağlık Anksiyetesi Envanteri'ni doldurdu.

Bulgular: Örneklem 101 kadın (%78) ve 29 erkek (%22) öğrenciden oluştu. Uyanma zamanı ile uykuya dalma süresi, telefon kullanımı ile uyku süresi, PUKİ ile çeşitli uyku parametreleri, EUÖ ile telefon kullanımı ve sağlık anksiyetesi ile hem PUKİ hem de EUÖ arasında zayıf pozitif korelasyonlar bulundu. Telefon kullanımı ile bilgisayar süresi, sirkadiyen ritim ile hem uyku süresi hem de telefon kullanımı arasında, ayrıca sirkadiyen ritim ile PUKİ ve EUÖ arasında zayıf negatif korelasyonlar gözlemlendi. EUÖ ile PUKİ puanları arasında ise orta düzeyde pozitif bir korelasyon saptandı.

Sonuç: Bulgular, çevrim içi eğitime bağlı yaşam tarzı değişikliklerinin öğrencilerin sirkadiyen ritimlerin, uyku kalitesinde ve sağlık anksiyetesinde değişimlerle ilişkili olabileceğini göstermektedir. Ancak çoğu ilişki zayıf düzeydedir, bu da sonuçların muhtemelen çoklu etkileşimli faktörlerden etkilendiğini düşündürmektedir.

Anahtar Sözcükler: Dijital cihaz kullanımı, uyku kalitesi, gündüz uykululuğu, sedanter yaşam tarzı, öğrenci sağlığı.

Introduction

Since the widespread adoption of online education, lifestyles have changed in many aspects. Social isolation and altered work and educational conditions have led to significant modifications in daily routines, including sleep patterns, circadian rhythms, and physical activity. Alongside these changes, concerns regarding health, fear of illness, and social isolation have been important contributors to anxiety and stress during the remote learning period¹.

Circadian rhythms are 24-hour cycles generated by molecular clocks that regulate physiological and behavioral processes. The circadian pacemaker, situated in the suprachiasmatic nucleus of the anterior hypothalamus, coordinates these signals to synchronize internal biological timing with external environmental cues. Disruptions in this system may result in cognitive dysfunction, metabolic syndrome, and mood disorders such as depression².

Sleep, regulated by both circadian rhythm and homeostatic balance, is essential for emotional and physical health. Sleep disturbances are linked to daytime tiredness, reduced concentration and memory performance, as well as difficulties in learning. Melatonin, which is released by the pineal gland, has a key function in controlling the

human sleep–wake rhythm. During the remote learning period, increased screen light exposure and reduced social interaction have been shown to alter melatonin secretion, sleep duration, and circadian rhythms^{3,4}.

Physical activity also influences circadian rhythms by modulating skeletal muscle molecular clocks. Exercise not only regulates tissue-specific gene expression but also improves circadian rhythm amplitude and phase. Engaging in regular aerobic exercise can improve sleep quality, lower cardiovascular risk factors, and promote melatonin secretion, thereby contributing to healthier sleep patterns^{5,6}.

The psychological burden associated with rapid lifestyle changes and remote learning has been considerable. Research has highlighted long-term lifestyle-related effects that involve neurocognitive, psychological, and neurological consequences⁷. According to a meta-analysis conducted by Xiong et al., the prevalence of anxiety disorders ranged between 6.3% and 50.9% during the early period of remote learning⁸. Circadian rhythm disorders and sleep disturbances are closely linked to affective disorders, and changes in mood and anxiety syndromes are common in this context⁷. In addition, health anxiety—defined as excessive concern about illness and health—has emerged as an important issue during and after the remote learning transition.

Recent studies have shown that screen exposure, sleep quality, physical activity, and psychological well-being are closely related in student populations. In online university students, higher levels of physical activity have been associated with fewer sleep problems, lower screen time, and better mental health indicators⁹. Similarly, among undergraduate healthcare students, physical activity, recreational screen time, sleep quality, and mood-related outcomes have been reported to be interrelated¹⁰. Recent studies in college students also suggest that physical activity may be associated with better sleep quality, while mobile phone-related behaviors may negatively affect sleep-related outcomes^{11,12}. Therefore, evaluating screen exposure, sedentary behavior, circadian rhythm, sleep quality, daytime sleepiness, physical activity, and health anxiety within the same framework may provide a more comprehensive understanding of the lifestyle-related consequences of online education. Accordingly, this study aimed to examine the associations between screen exposure, sedentary behavior, circadian rhythm, sleep quality, daytime sleepiness, physical activity, and health anxiety among university students during the online education period.

Materials and Methods

Study Design

The participants of this study were university students enrolled in various faculties of the University of Health Sciences. The required sample size was determined using G*Power version 3.1 before data collection. Since the primary aim of the study was to examine the relationships among the study variables, the calculation was based on a two-tailed bivariate correlation analysis. The expected correlation coefficient was set at $\rho = 0.243$ based on a similar previously published study conducted among university students,

which reported weak correlations between sleep quality and physical activity- and stress-related variables¹³. With $\alpha = 0.05$, $\rho_{H0} = 0$, $\rho_{H1} = 0.243$, and a statistical power of 80%, the minimum required sample size was calculated as 130 participants.

No stratification method based on gender, age, academic department, or year of study was used during participant recruitment. Participants were recruited according to the predefined inclusion and exclusion criteria.

Inclusion criteria:

- Age 18–25 years
- Body mass index 18.5–29.5 kg/m²
- Non-smokers, non-alcohol users

Exclusion criteria:

- Chronic illness or orthopedic problems
- Antibiotic use within the past 8 weeks
- Vitamin, mineral, probiotic, steroid, or gastrointestinal medication within the past 4 weeks
- Surgical operation in the past year
- Hormone therapy
- Psychiatric or psychological treatment history

The BMI range of 18.5–29.5 kg/m² was selected to exclude individuals with underweight or obesity, as extreme BMI values may independently affect sleep quality, circadian rhythm, physical activity level, and anxiety-related outcomes. This criterion was used to reduce potential confounding effects related to body weight status.

Data Collection Tools

Prior to the commencement of the study, participants' socio-demographic information, including age, height, and weight, was collected. In addition, participants were asked about their sleep onset latency, wake-up times, nighttime light exposure, and screen time.

Morningness–Eveningness Questionnaire: The questionnaire serves to classify individuals as morning or evening types based on their circadian rhythm characteristics. The questionnaire form consists of a total of 19 Likert-type questions, and the answers are given in four options. Typing is determined by summing the scores obtained after the application of the questionnaire. Individuals scoring between 70 and 86 points are

classified as definite morning types, whereas those obtaining scores between 16 and 30 are identified as definite evening types. The Turkish adaptation, along with validity and reliability analyses of the questionnaire, was previously performed^{14,15}.

Pittsburgh Sleep Quality Index (PSQI): The scale, originally developed by Buysse et al., assesses sleep quality and related disturbances over the preceding month. The PSQI consists of seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each domain is rated on a scale from 0 to 3, and their sum yields the overall score. A total score above five reflects poor sleep quality, whereas a score of five or lower suggests good sleep quality¹⁶. The Turkish version of the scale was previously validated¹⁷.

Epworth Sleepiness Scale (ESS): Johns designed this self-report scale to assess daytime sleepiness by evaluating an individual's likelihood of dozing off in different daily contexts and at specific times. The scale contains eight questions answered by the individual. The overall score varies from 0 to 24, where higher scores reflect a greater tendency toward daytime sleepiness¹⁸. The Turkish adaptation has been conducted¹⁹.

Although both the PSQI and ESS are sleep-related instruments, they assess different dimensions of sleep. The PSQI evaluates sleep quality and sleep-related disturbances over the previous month, whereas the ESS assesses the tendency for daytime sleepiness in daily situations. Therefore, both scales were used together to provide a more comprehensive assessment of sleep-related outcomes.

International Physical Activity Questionnaire (IPAQ): This questionnaire was designed to assess physical activity levels among individuals aged 15 to 65. It offers reliable and comparable data by evaluating daily activity patterns reported by participants. The tool records time spent on walking, moderate- and vigorous-intensity activities, as well as sedentary behavior²⁰. The Turkish version has been previously validated and tested for reliability²¹.

Health Anxiety Inventory – Short Form: “Salkovskis et al. developed this scale to evaluate health anxiety levels. It comprises 18 self-reported items: 14 use a four-point Likert-type format assessing participants' psychological state, while the other four require individuals to imagine their emotional responses in the case of having a serious illness. Each item is scored between 0 and 3, and higher total scores correspond to greater health anxiety²². The Turkish validity and reliability study has been conducted²³.

Ethical Considerations

Approval for the research was granted by the Ethics Committee of Hamidiye Scientific Research at the University of Health Sciences (22.04.2022; Decision No: 12/8).

Statistical Analysis

The evaluation of the research data was carried out using the SPSS statistical package program (IBM Statistics, 22.0, Chicago, IL, USA). To evaluate the normality of the dataset, the Shapiro–Wilk test was performed. Correlations between measurements obtained from individuals were evaluated using parametric (Pearson) or non-parametric (Spearman) correlation analyses depending on whether the data distribution was normal or not. In addition to correlation analyses, logistic regression analysis was performed to identify factors associated with excessive daytime sleepiness. Participants were categorized according to ESS scores as having normal daytime sleepiness ($ESS < 10$) or excessive daytime sleepiness ($ESS \geq 10$)²⁴. Variables that were statistically significant or marginally significant in univariate logistic regression analyses were included in the multivariate logistic regression model using the Enter method. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Results

A total of 130 healthy university students were evaluated. The demographic characteristics of the participants, sleep onset latencies, wake-up times, nighttime light exposure, average sleep durations, average time spent at the computer, and average time spent on the phone are shown in Tables 1 and 2.

Table 1. Distribution of participants by gender and dominant hand

Variable	n	%
Gender		
Female	101	77.7
Male	29	22.3
Dominant Hand		
Right	115	88.5
Left	15	11.5

n = number of participants, % = percentage

Table 2. Demographic Characteristics, Sleep Parameters, and Screen Time of Participants

Variables	N	Min.	Max.	Mean $\pm$ SD
Age (years)	130	18	25	21.29 $\pm$ 1.647
Height (cm)	130	147	194	167.68 $\pm$ 8.771
Weight (kg)	130	40	119	63.72 $\pm$ 14.434
Sleep Onset Latency (min)	130	5	240	29.68 $\pm$ 34.737
Wake-up Latency (min)	130	0	90	13.85 $\pm$ 13.778
Nighttime Light Exposure (min)	130	0	540	58.85 $\pm$ 98.260
Average Sleep Duration (hours)	130	4	10	7.64 $\pm$ 1.299
Average Time Spent at Computer (hours)	130	0	10	3.21 $\pm$ 2.654
Average Time Spent on Phone (hours)	130	0	12	4.62 $\pm$ 2.544

N = number of participants, Min. = Minimum, Max. = Maximum, SD = Standard Deviation

The scores obtained from the Morningness–Eveningness Questionnaire, PSQI, ESS, IPAQ, and Health Anxiety Inventory used in the study are presented in Table 3.

Table 3. Scores Obtained from the Morningness–Eveningness Questionnaire, PSQI, ESS, IPAQ, and Health Anxiety Scale

Variable	N	Min.	Max.	Mean $\pm$ SD
Morningness–Eveningness Questionnaire	130	22	72	47.83 $\pm$ 9.146
Pittsburgh Sleep Quality Index (PSQI)	130	11	25	15.80 $\pm$ 2.666
Epworth Sleepiness Scale (ESS)	130	0	20	7.15 $\pm$ 4.713
International Physical Activity Questionnaire (IPAQ)	130	0	26625	1799.34 $\pm$ 3206.827
Health Anxiety Scale	130	3	53	18.25 $\pm$ 7.630

n = number of participants, Min. = Minimum, Max. = Maximum, SD = Standard Deviation

In order to determine whether there is a linear relationship between the variables and, if so, its direction and strength, Spearman correlation analysis was performed (Table 4). A weak positive correlation was found between wake-up time and sleep onset latency, between time spent on the phone and average sleep duration, between PSQI and sleep

onset latency, wake-up time and average sleep duration, between ESS and time spent on the phone, and between Health Anxiety Inventory scores and PSQI and ESS. A weak negative correlation was found between time spent on the phone and average computer time, between circadian rhythm and average sleep duration and time spent on the phone, between PSQI and circadian rhythm, and between ESS and circadian rhythm. A moderate positive correlation was found between ESS and PSQI scores.

Table 4. Correlational relationships among research variables

Variables		Sleep Onset Latency (min)	Wake-up Latency (min)	Nighttime Light Exposure (min)	Average Sleep Duration (h)	Avg. Time at Computer (h)	Avg. Time on Phone (h)	Morningness –Eveningness Score	PSQI Total Score	ESS Total Score	IPAQ Total Score	Health Anxiety Scale Score
Sleep Onset Latency (min)	r	1.000										
	p	.										
Wake-up Latency (min)	r	.337**	1.000									
	p	.000	.									
Nighttime Light Exposure (min)	r	-.010	.164	1.000								
	p	.912	.063	.								
Average Sleep Duration (h)	r	-.003	.023	-.112	1.000							
	p	.976	.799	.205	.							
Avg. Time at Computer (h)	r	.000	.021	.023	-.024	1.000						
	p	.997	.817	.795	.787	.						
Avg. Time on Phone (h)	r	.157	.082	-.072	.276**	-.184*	1.000					
	p	.074	.354	.414	.001	.036	.					
Morningness –Eveningness Score	r	-.143	-.299**	.011	-.322**	.144	-.246**	1.000				
	p	.105	.001	.897	.000	.103	.005	.				
PSQI Total Score	r	.310**	.213*	.026	.392**	.034	.110	-.393**	1.000			
	p	.000	.015	.772	.000	.702	.212	.000	.			
ESS Total Score	r	-.029	.102	.082	.135	-.149	.247**	-.208*	.412*	1.000		
	p	.745	.248	.352	.126	.092	.005	.017	.000	.		
IPAQ Total Score	r	.004	.058	.026	-.111	.017	.082	.002	-.111	-.007	1.000	
	p	.968	.517	.772	.209	.848	.357	.984	.212	.933	.	
Health Anxiety Scale Score	r	-.002	.141	-.091	.076	.067	.052	-.152	.318*	.371**	-.083	1.000
	p	.985	.111	.302	.389	.446	.557	.084	.000	.000	.347	.

Pearson Correlation Analysis **p < 0.01 (**)**; **p < 0.05 (*)**; min = minutes, h = hours, PSQI = Pittsburgh Sleep Quality Index, ESS = Epworth Sleepiness Scale, IPAQ = International Physical Activity Questionnaire

In the univariate logistic regression analyses, PSQI total score, health anxiety score, and average sleep duration were significantly associated with excessive daytime sleepiness, while average time spent on the phone and Morningness–Eveningness Questionnaire score showed marginal associations. Average time spent at the computer, IPAQ total score, and nighttime light exposure were not significantly associated with excessive daytime sleepiness.

In the multivariate logistic regression model, PSQI total score, health anxiety score, average time spent on the phone, and Morningness–Eveningness Questionnaire score were included as independent variables. The overall model was statistically significant ($\chi^2=33.872$, $df=4$, $p<0.001$) and showed acceptable goodness of fit according to the Hosmer–Lemeshow test ($\chi^2=9.174$, $df=8$, $p=0.328$). The model explained 32.2% of the variance in excessive daytime sleepiness according to Nagelkerke R^2 . PSQI total score ($OR=1.297$, 95% $CI:1.065–1.579$, $p=0.010$) and health anxiety score ($OR=1.118$, 95% $CI:1.043–1.199$, $p=0.002$) were independently associated with excessive daytime sleepiness. Average time spent on the phone and Morningness–Eveningness Questionnaire score were not significant independent predictors in the multivariate model.

Table 5. Multivariate logistic regression analysis of factors associated with excessive daytime sleepiness

Variables	B	SE	Wald	p	OR	95% CI for OR
PSQI total score	0.260	0.100	6.713	0.010	1.297	1.065–1.579
Health Anxiety Scale total score	0.112	0.035	9.997	0.002	1.118	1.043–1.199
Average time spent on phone (h)	0.127	0.086	2.160	0.142	1.135	0.959–1.344
Morningness–Eveningness Questionnaire score	-0.007	0.027	0.073	0.787	0.993	0.941–1.047

Model statistics: $\chi^2 = 33.872$, $df = 4$, $p < 0.001$; Hosmer–Lemeshow $\chi^2 = 9.174$, $df = 8$, $p = 0.328$; Nagelkerke $R^2 = 0.322$.

Note: Excessive daytime sleepiness was defined as $ESS \geq 10$. Variables were entered into the model using the Enter method. SE = Standard Error; OR = Odds Ratio; CI = Confidence Interval; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth Sleepiness Scale.

Discussion

This study evaluated the associations between lifestyle changes during the remote learning period and circadian rhythm, sleep patterns, physical activity, and health anxiety among university students. Data were collected during the early normalization period in Turkey, when online education was still ongoing. Thus, the findings reflect a transitional stage in which students were adapting to new routines while adjusting to changes brought by the shift to online education.

One of the most important findings was the increase in students' screen exposure. Extended use of digital devices has been linked in previous studies to disrupted sleep patterns and delayed circadian rhythms²⁵. In our sample, sleep quality was below the ideal level, consistent with meta-analyses showing significant declines in sleep quality during the remote learning period^{26,27}. Although our Epworth Sleepiness Scale (ESS) results indicated relatively good daytime functioning, poor sleep quality was still

observed, highlighting the discrepancy often reported between subjective sleep quality and daytime sleepiness²⁸.

Circadian rhythm disturbances have been widely reported during the remote learning period, particularly in the form of delayed sleep phase and eveningness tendencies²⁵. In our study, however, Morningness–Eveningness Questionnaire scores were within the medium range, suggesting no radical shift in chronotype. This may reflect the role of structured class schedules, which helped students maintain regular wake–sleep timing. Awareness of healthy lifestyle habits may also have mitigated a shift toward eveningness.

Interestingly, physical activity levels in our study were generally above average. Similar findings were reported by Blanco et al., who observed that sedentary behaviors increased during the remote learning period but that physical activity levels also rose, possibly due to individuals' greater awareness of health risks and their deliberate efforts to remain active²⁹. On the other hand, other studies documented decreases in physical activity among students³⁰. These conflicting results may be explained by differences in socioeconomic status, living conditions, or regional restrictions. Our findings suggest that at least some students successfully adapted their routines by incorporating physical activity despite increased sedentary behaviors.

Health anxiety levels were within normal limits in our sample. This contrasts with population-based studies reporting elevated anxiety during the early transition to online education, with rates rising as high as 50.9%⁸. A possible explanation is that our participants were students from health-related fields. Greater knowledge about disease processes and coping strategies may have reduced anxiety levels, buffering against stressors related to lifestyle changes.

In the multivariate logistic regression analysis, poorer sleep quality and higher health anxiety scores were independently associated with excessive daytime sleepiness. This finding supports the close relationship between subjective sleep quality, daytime functioning, and psychological factors in university students.

Limitations: This study has several limitations. First, the data were collected during the early normalization period following the transition to online education, when restrictions had eased but online education was still ongoing. Therefore, the results may not fully reflect conditions during the strict lockdown period. Second, the cross-sectional design does not allow causal inferences. Third, variables such as stress level, diet, medication use, or psychiatric history, which could influence sleep and anxiety, were not controlled. Fourth, reliance on self-report questionnaires introduces the risk of subjective bias. Finally, the unequal gender distribution of the sample, with a higher proportion of female participants, may limit the generalizability of the findings to the broader university student population and should be considered when interpreting the results. Future studies with larger and more gender-balanced samples are recommended.

Conclusion

Despite these limitations, the study contributes to the growing body of evidence on how lifestyle changes associated with online education and increased screen exposure may influence sleep, circadian rhythm, physical activity, and health anxiety in university students. Although most associations were weak, the findings suggest complex interactions between behavioral, psychological, and physiological factors. Future longitudinal and multi-center studies are needed to clarify causal pathways and long-term consequences.

Ethics Committee Approval: This research complies with all relevant national regulations, institutional policies, and the principles of the Helsinki Declaration, and was approved by the Ethics Committee of Hamidiye Scientific Research, University of Health Sciences (Date: 22.04.2022; Decision No: 12-8).

Informed Consent: The rights of all participants were protected, and written informed consent was obtained prior to procedures, in accordance with the Helsinki Declaration.

Author Contributions: Concept – S.A., Z.K.; Design – S.A., G.K., M.B.U.; Supervision – Z.K., E.S.A.; Resources – S.A., E.S.A., B.A.; Materials – M.B.U.; Data Collection and/or Processing – S.A., G.K., M.B.U.; Analysis and/or Interpretation – S.A., E.S.A., B.A.; Literature Review – S.A., G.K., M.B.U.; Writing – S.A., G.K., M.B.U., E.S.A.; Critical Review – Z.K., E.S.A., B.A.

Conflict of Interest: The authors declare no conflict of interest.

Financial Disclosure: The authors declared that they did not receive financial support for this study.

REFERENCES

1. Sinha M, Pande B, Sinha R. Impact of COVID-19 lockdown on sleep-wake schedule and associated lifestyle related behavior: A national survey. *Journal of Public Health Research*. 2020;9(3):jpshr. 2020.1826.
2. Jagannath A, Taylor L, Wakaf Z, Vasudevan SR, Foster RG. The genetics of circadian rhythms, sleep and health. *Human Molecular Genetics*. 2017;26(R2):R128-R138.
3. Xie Z, Chen F, Li WA, et al. A review of sleep disorders and melatonin. *Neurological Research*. 2017;39(6):559-565.
4. Canello R, Soranna D, Zambra G, Zambon A, Invitti C. Determinants of the lifestyle changes during COVID-19 pandemic in the residents of Northern Italy.

International Journal of Environmental Research and Public Health.
2020;17(17):6287.

5. Gabriel BM, Zierath JR. Circadian rhythms and exercise—re-setting the clock in metabolic disease. *Nature Reviews Endocrinology.* 2019;15(4):197-206.
6. Hower IM, Harper SA, Buford TW. Circadian rhythms, exercise, and cardiovascular health. *Journal of Circadian Rhythms.* 2018;16
7. Boiko DI, Skrypnikov AM, Shkodina AD, Hasan MM, Ashraf GM, Rahman M. Circadian rhythm disorder and anxiety as mental health complications in post-COVID-19. *Environmental Science and Pollution Research.* 2022;29(19):28062-28069.
8. Xiong J, Lipsitz O, Nasri F, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *Journal of Affective Disorders.* 2020;277:55-64.
9. Boraita RJ, González-García H, Pérez JG, et al. The impact of physical activity levels on mental health and sleep quality in university online students. *Journal of Public Health.* doi: 10.1007/s10389-025-02559-1
10. AlKhenazi AK, Shakeeb FN, Fredericks S, Gaynor D. Physical activity levels, recreational screen time, sleep quality and mood among young adult healthcare students at an international university in Bahrain: a cross-sectional study. *BMJ Open.* May 15 2025;15(5):e093655. doi: 10.1136/bmjopen-2024-093655
11. Yin Z, Yang C, Liu T, et al. The relationship between physical activity and sleep quality among college students: The chain-mediating effects of self-control and mobile phone addiction. *PLoS One.* 2024;19(12):e0315930. doi: 10.1371/journal.pone.0315930
12. Zhu W, Liu J, Lou H, Mu F, Li B. Influence of smartphone addiction on sleep quality of college students: The regulatory effect of physical exercise behavior. *PloS one.* 2024;19(7):e0307162.
13. İyigün G, Angın E, Kırmızıgil B, Öksüz S, Özdil A, Malkoç M. Üniversite öğrencilerinde uyku kalitesinin mental sağlık, fiziksel sağlık ve yaşam kalitesi ile ilişkisi. *Journal of Exercise Therapy and Rehabilitation.* 2017;4(3):125-133.
14. Pündük Z, Gür H, Ercan İ. Sabahçıl-Akşamcıl Anketi Türkçe uyarlamasında güvenilirlik çalışması. *Türk Psikiyatri Dergisi.* 2005;
15. Horne JA, Ostberg O. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology.* 1976;4(2):97-110.

16. Buysse DJ, Reynolds III CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*. 1989;28(2):193-213.
17. Ağargün MY. Pittsburgh uyku kalitesi indeksinin geçerliği ve guvenirligi. *Türk Psikiyatri Dergisi*. 1996;7:107-115.
18. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *sleep*. 1991;14(6):540-545.
19. Ağargün MY, Çilli As, Kara H, et al. Epworth Uykululuk Ölçeği'nin geçerliği ve guvenirligi. *Türk Psikiyatri Dergisi*. 1999;10(4):261-267.
20. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*. 2003;35(8):1381-1395.
21. Saglam M, Arikan H, Savci S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. *Perceptual and Motor Skills*. 2010;111(1):278-284.
22. Salkovskis PM, Rimes KA, Warwick H, Clark D. The Health Anxiety Inventory: development and validation of scales for the measurement of health anxiety and hypochondriasis. *Psychological medicine*. 2002;32(5):843-853.
23. Aydemir Ö, Kirpinar I, Sati T, Uykur B, Cengiz C. Sağlık Anksiyetesi Ölçeği'nin Türkçe için guvenirlilik ve geçerlilik çalışması. *Archives of Neuropsychiatry/ Noropsikiatri Arsivi*. 2013;50(4)
24. Trimmel K, Żebrowska M, Böck M, et al. Wanted: a better cut-off value for the Epworth Sleepiness Scale. *Wiener Klinische Wochenschrift*. 2018;130(9):349-355.
25. Tao S, Wu X, Li S, et al. Circadian rhythm abnormalities during the COVID-19 outbreak related to mental health in China: a nationwide university-based survey. *Sleep Medicine*. 2021;84:165-172.
26. Jahrami H, BaHammam AS, Bragazzi NL, Saif Z, Faris M, Vitiello MV. Sleep problems during the COVID-19 pandemic by population: a systematic review and meta-analysis. *Journal of Clinical Sleep Medicine*. 2021;17(2):299-313.
27. Genta FD, Rodrigues Neto GB, Sunfeld JPV, et al. COVID-19 pandemic impact on sleep habits, chronotype, and health-related quality of life among high school students: a longitudinal study. *Journal of Clinical Sleep Medicine*. 2021;17(7):1371-1377.

- 28.** da Silva Beltrame KW, Trindade-Suedam IK, Trindade SHK, Marzano-Rodrigues MN. Web survey during COVID-19 pandemic in São Paulo state: how are medical students sleeping and living? *Sleep Science*. 2022;15(4):374.
- 29.** Romero-Blanco C, Rodríguez-Almagro J, Onieva-Zafra MD, Parra-Fernández ML, Prado-Laguna MdC, Hernández-Martínez A. Physical activity and sedentary lifestyle in university students: changes during confinement due to the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*. 2020;17(18):6567.
- 30.** Bertrand L, Shaw KA, Ko J, Deprez D, Chilibeck PD, Zello GA. The impact of the coronavirus disease 2019 (COVID-19) pandemic on university students' dietary intake, physical activity, and sedentary behaviour. *Applied Physiology, Nutrition, and Metabolism*. 2021;46(3):265-272.

Associations of Diet Quality and Body Composition with Sleep Quality in Professional Athletes: A Cross-Sectional Study*

Göksu ŞEN POLAT**, Merve YILMAZ***

Abstract

Aim: Sleep quality is vital for recovery and performance in elite sports. This study investigated the associations between body composition, diet quality, and sleep quality in professional athletes within the context of biological rhythms.

Method: In this cross-sectional study of 89 professional athletes (football, volleyball, basketball), body composition was determined via the Jackson-Pollock 7-site skinfold method. Diet quality and sleep quality were assessed using the Healthy Eating Index-2015 (HEI-2015) and Pittsburgh Sleep Quality Index (PSQI), respectively.

Results: Most athletes (83.2%) had moderate diet quality and 94.4% reported good sleep quality. No significant association was found between overall diet quality and sleep quality ($p=0.723$). However, athletes with poor sleep quality had significantly higher body fat percentages ($p=0.003$). Diet quality significantly differed by training duration ($p<0.05$) and nutrition knowledge ($p=0.034$). Sleep quality was significantly associated with smoking and sleep-support supplement use ($p<0.05$). A weak but significant positive correlation existed between PSQI scores and body fat percentage ($r=0.293$, $p<0.05$).

Conclusion: Overall diet quality was not directly associated with sleep quality among professional athletes. However, sleep quality was significantly related to body fat percentage as well as several training and lifestyle characteristics. These findings highlight the importance of addressing sleep quality and body composition together when developing nutrition and lifestyle strategies aimed at improving recovery and performance in elite athletes.

Keywords: Body composition, diet quality, professional athletes, sleep quality.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 21.05.2026 Kabul / Accepted: 12.08.2026

DOI: <https://doi.org/10.38079/igusabder.1956723>

* This study has been derived from the master's thesis titled "The Relationship Between Diet Quality and Sleep Quality in Professional Athletes", which was accepted in 2025 at İzmir Tınaztepe University, Institute of Health Sciences, Department of Nutrition and Dietetics and prepared by Göksu ŞEN POLAT under the consultancy of Asst. Prof. Dr. Merve YILMAZ.

** MSc. RD., İzmir Tınaztepe University, Institute of Health Sciences, Department of Nutrition and Dietetics, İzmir, Türkiye. E-mail: dytgoksusen@gmail.com ORCID <https://orcid.org/0009-0000-9766-5604>

*** (Corresponding Author) Asst. Prof. Dr., İzmir Tınaztepe University, Faculty of Health Sciences, Department of Nutrition and Dietetics, İzmir, Türkiye. E-mail: merve.yilmaz@tinaztepe.edu.tr ORCID <https://orcid.org/0000-0003-0730-8908>

ETHICAL STATEMENT: Ethical approval for the study was obtained from the Tınaztepe University Clinical Research Ethics Committee (16/11/2023–2023/30).

Profesyonel Sporcularda Diyet Kalitesi ve Vücut Kompozisyonunun Uyku Kalitesi ile İlişkisi: Kesitsel Bir Çalışma

Öz

Amaç: Uyku kalitesi, elit sporlarda iyileşme ve performans için hayati öneme sahiptir. Bu çalışma, biyolojik ritimler bağlamında profesyonel sporcularda vücut kompozisyonu, beslenme kalitesi ve uyku kalitesi arasındaki ilişkileri araştırmıştır.

Yöntem: 89 profesyonel sporcunun (futbol, voleybol, basketbol) katıldığı bu kesitsel çalışmada, vücut kompozisyonu Jackson-Pollock 7 bölgesi deri kıvrımı yöntemiyle belirlenmiştir. Beslenme kalitesi ve uyku kalitesi sırasıyla Sağlıklı Beslenme Endeksi-2015 (HEI-2015) ve Pittsburgh Uyku Kalitesi Endeksi (PSQI) kullanılarak değerlendirilmiştir. İstatistiksel güç (1-β) 0,99'dur.

Bulgular: Sporcuların çoğu (%83,2) orta düzeyde beslenme kalitesine sahipken, %94,4'ü iyi uyku kalitesine sahip olduğunu bildirmiştir. Genel beslenme kalitesi ile uyku kalitesi arasında anlamlı bir ilişki bulunmamıştır ($p=0,723$). Bununla birlikte, uyku kalitesi düşük olan sporcuların vücut yağ yüzdeleri anlamlı derecede daha yüksek bulunmuştur ($p=0,003$). Diyet kalitesi, antrenman süresi ve beslenme bilgisi ($p<0,05$) ile anlamlı derecede farklılık göstermiştir. Uyku kalitesi, sigara içme ve uyku destekleyici takviye kullanımı ile anlamlı derecede ilişkili olarak bulunmuştur ($p<0,05$). PSQI puanları ile vücut yağ yüzdesi arasında zayıf ancak anlamlı pozitif bir korelasyon gösterilmiştir ($r=0,293$, $p<0,05$).

Sonuç: Genel olarak diyet kalitesi profesyonel sporcularda uyku kalitesi ile doğrudan ilişkili bulunmamıştır. Bununla birlikte, uyku kalitesi; vücut yağ yüzdesi ile bazı antrenman ve yaşam tarzı özellikleriyle anlamlı düzeyde ilişkili bulunmuştur. Bu bulgular, elit sporcularda performansın ve toparlanmanın optimize edilmesine yönelik müdahalelerde, beslenme yaklaşımının yanı sıra uyku kalitesi ve vücut kompozisyonunun birlikte değerlendirilmesinin önemini ortaya koymaktadır.

Anahtar Sözcükler: Diyet kalitesi, vücut kompozisyonu, profesyonel sporcular, uyku kalitesi.

Introduction

Sleep is a vital physiological state characterized by reduced responsiveness to external stimuli. While the body remains metabolically active, behavioral activity is significantly reduced, making sleep an essential factor for overall health and well-being. Sleep duration can markedly influence sleep quality, which directly affects cognitive abilities, immune function, hormonal regulation, and energy expenditure. By supporting tissue repair, energy balance, and cognitive function, sleep provides the primary mechanism for daily recovery. Consequently, for professional athletes, obtaining adequate sleep is a crucial component of future athletic performance. Evidence shows that low levels of both quantity and quality of sleep have negative impacts on athletic performance; impaired decision-making abilities, increased risk of injury, as well as increased prevalence of mental health disorders such as depression and anxiety are all related to lack of adequate quality of sleep¹⁻⁴. Evidence shows that low sleep quantity and poor sleep quality negatively impact athletic performance. Impaired decision-making abilities, increased injury risk, and a higher prevalence of mental health disorders—such as depression and anxiety—are all closely linked to a lack of adequate sleep quality.

Multiple factors influence sleep quality, including age, lifestyle behaviors, stress levels, and nutritional habits. There is increasing research that dietary intake and overall eating patterns play a significant role in shaping sleep quality. Diets high in carbohydrate content may decrease the time it takes to fall asleep, while protein-rich diet patterns may improve the quality of our sleep, whereas high-fat diets may result in less total sleep and poorer outcomes⁵⁻⁸. In addition, some nutrients and supplements, such as melatonin, magnesium, and tryptophan have been shown to improve sleep quality through the regulation of circadian rhythms and the production of neurotransmitters^{9,10}.

Beyond individual nutrients, diet quality represents a comprehensive indicator of how closely an individual's overall dietary pattern aligns with established healthy eating guidelines. Individuals with a high-quality diet consume a well-balanced amount of macro- and micronutrients, which enhances immunity, limits detrimental oxidative stress, and improves metabolic regulation. In athletes, optimal diet quality is particularly critical, as it supports training adaptation, recovery processes, body composition management, and long-term performance sustainability¹¹⁻¹³. Importantly, diet quality may indirectly influence sleep quality through its effects on body composition, energy availability, and metabolic health—factors that are closely linked to sleep regulation in athletic populations^{14,15}.

Body composition, particularly body fat percentage and fat-free mass, has increasingly been recognized as an important correlate of sleep quality in athletes. Evidence suggests that poor sleep is associated with higher body fat levels, disrupted hormonal regulation, and adverse metabolic outcomes, which may negatively affect recovery processes and athletic performance^{14,16}. Conversely, adequate sleep duration and quality have been linked to more favorable body composition profiles, enhanced training adaptations, and improved recovery capacity^{4,17}.

Taken together, these findings highlight the need to examine sleep, diet quality, and body composition within an integrated framework when evaluating health and performance outcomes in professional athletes. Although sleep and nutrition have been extensively studied as independent determinants of athletic performance, research simultaneously examining diet quality and sleep quality in professional athletes remains limited. Moreover, existing findings regarding the effects of specific nutrients and dietary supplements on sleep outcomes are often inconsistent, highlighting the need for further evidence-based research^{1,9,18}. Therefore, the present study aimed to investigate the relationship between diet quality and sleep quality in professional athletes while also considering associated anthropometric and body composition parameters.

Material and Methods

Study Design and Sample

This descriptive, cross-sectional study was conducted between September 2023 and May 2025 with professional athletes aged 18–65 years who were competing in first- and second-division volleyball, basketball, and football clubs in İzmir, Türkiye. The study was

carried out through face-to-face interviews with athletes who voluntarily agreed to participate.

The required sample size was calculated using G*Power software (v3.1.9.2) with a 95% confidence level, an effect size of 0.30, and a theoretical power of 0.80, resulting in a minimum sample size of 84 participants.

Data Collection Instruments

Study data were collected using three main instruments to comprehensively assess athletes' demographic characteristics, dietary habits, sleep parameters, and body composition.

Athlete Information Form: This form was used to obtain data on participants' demographic characteristics, anthropometric measurements, sports history, subjective perceptions related to nutrition and sleep, and the use of sleep-support supplements.

Anthropometric Measurements and Body Composition: Anthropometric measurements, including height, body weight, and body composition, were assessed using standardized procedures. Height was measured using a fixed stadiometer, and body weight was measured with a calibrated digital scale. Body composition was assessed using the seven-site skinfold thickness protocol developed by Jackson and Pollock¹⁹, which includes measurements at the chest, triceps, subscapular, midaxillary, suprailiac, abdomen, and thigh sites.

Skinfold thickness measurements were obtained using a Harpenden skinfold caliper (British Indicators Ltd., UK). Three measurements were taken at each anatomical site, and the mean value was used for analysis. The sum of skinfold thicknesses and age were entered into sex-specific Jackson and Pollock equations to estimate body density (g/cm^3)¹⁹. Body fat percentage was subsequently calculated from body density using the Siri conversion equation²⁰.

Pittsburgh Sleep Quality Index (PSQI): Sleep quality and sleep disturbances over the previous month were assessed using the Pittsburgh Sleep Quality Index (PSQI)²¹. The PSQI is a 19-item, four-point Likert-type scale comprising seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Eighteen items are included in scoring, while the 19th item is descriptive and not scored. The total PSQI score ranges from 0 to 21, with scores ≤ 5 indicating good sleep quality and scores > 5 indicating poor sleep quality.

Three-Day Food Record and Diet Quality (HEI-2015): Dietary intake was assessed using a prospective three-day food record, including two non-consecutive weekdays and one weekend day. To minimize recall and portion estimation bias, records were reviewed during face-to-face interviews using a photographic food atlas. Recorded food intakes and dietary supplements (e.g., protein powders, pre-workouts) were

analyzed using the Nutrition Information System (BEBİS, v8.2) to obtain daily energy and macro- and micronutrient intakes.

Diet quality was evaluated using the Healthy Eating Index–2015 (HEI-2015), which assesses adherence to the 2015–2020 Dietary Guidelines for Americans across 13 components (e.g., fruits, vegetables, whole grains, protein foods, fatty acids, sodium). Per standard HEI-2015 protocols, scoring was derived strictly from food and beverage intakes. Component scores were normalized per 1,000 kcal of energy intake, and each component was scored individually. Total HEI-2015 scores were categorized as low (0–50), moderate (51–80), or high (81–100) diet quality²².

Athletes' energy and macronutrient intakes were evaluated according to the Nutrition and Athletic Performance guidelines²³. Average ACSM recommendations were used as reference values. Individual intake adequacy was calculated as the percentage of actual intake relative to recommended intake and classified as <67% (insufficient), 67–133% (adequate), or >133% (excessive).

To eliminate inter-observer variability, all anthropometric measurements were performed by a single trained researcher using standardized protocols, and three consecutive measurements were taken at each site to calculate a mean value. Dietary records were reviewed with participants to reduce recall bias.

Ethical Statement

Ethical approval for the study was obtained from the Tınaztepe University Clinical Research Ethics Committee (16/11/2023–2023/30). Written informed consent was obtained from all participants prior to data collection.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as number (n), percentage (%), mean ($\bar{x}$), standard deviation (SD), median, and interquartile range. Normality of data distribution was assessed using the Shapiro–Wilk test.

For normally distributed variables, independent samples t-tests and one-way analysis of variance (ANOVA) were used. For non-normally distributed variables, the Kruskal–Wallis H test was applied. Categorical variables were compared using Fisher's exact test and the chi-square test. Pearson correlation analysis was conducted to examine associations between continuous variables. A p-value <0.05 was considered statistically significant.

Results

A total of 89 professional athletes participated in the study, of whom 61.8% were football players, 27.0% volleyball players, and 11.2% basketball players. Most participants were

male (73.0%). Information regarding the general characteristics and anthropometric data of the athletes is given in Table 1.

Table 1. Sociodemographic, anthropometric, lifestyle, and training characteristics of the athletes.

Continuous Variables	Mean $\pm$ SD	
Age (years)	20.57 $\pm$ 3.99	
Years of active sports participation (years)	11.07 $\pm$ 4.81	
Weekly training frequency (days/week)	5.88 $\pm$ 1.07	
Daily training duration (hours/day)	2.69 $\pm$ 0.78	
Body weight (kg)	72.67 $\pm$ 11.88	
Height (cm)	182.60 $\pm$ 8.82	
BMI (kg/m ²)	21.7 $\pm$ 1.98	
Body fat percentage (%)	10.33 $\pm$ 3.99	
Body density (g/cm ³)	1.07 $\pm$ 0.009	
Categorical Variables	n	%
Sex		
Female	24	27
Male	65	73
Marital status		
Married	9	10.1
Single	80	89.9
Educational Level		
High school graduate	57	64
University student	21	23.6
University graduate	11	12.4
Sport discipline		
Football	55	61.8
Volleyball	24	27
Basketball	10	11.2
Use of sleep-support supplements		
Yes	15	16.9
No	74	83.1
Type of supplement used*		
Magnesium	12	80.0
Melatonin	3	20.0
Perceived relationship between nutrition and sleep quality**		
No opinion		
Closely related	16	18.0
Not related	70	78.7
	3	3.4

Sports nutrition knowledge**		
Yes	49	55.1
No	5	5.6
Insufficient	35	39.3
Smoking status		
Never smoked	76	85.4
Currently smoking	4	4.5
Former smoker	9	10.1

BMI: Body Mass Index * Evaluated among n = 15 ** Subjective assessments.

The mean total diet quality score was 67.25 ± 10.34 . Based on diet quality classification, 11.2% (n=10) of athletes had poor diet quality, 83.2% (n=74) moderate diet quality, and 5.6% (n=5) good diet quality.

The mean sleep quality score was 2.02 ± 1.19 . Most athletes (94.4%, n = 84) were classified as having good sleep quality, while 5.6% (n = 5) had poor sleep quality. No significant association was observed between overall diet quality and sleep quality ($p = 0.723$) (Table 2).

Table 2. Association between diet quality and sleep quality.

Sleep Quality n (%)				TEST
		Good	Poor	χ^2 : 1.074 $p = 0.723$
Diet Quality n (%)	Poor	10 (11.2)	0 (0.00)	
	Moderate	69 (77.5)	5 (100.0)	
	Good	5 (5.6)	0 (0.00)	

χ^2 : Fisher's Exact Test

Diet quality differed significantly according to weekly training duration ($p = 0.001$) and daily training duration ($p = 0.010$). Athletes with poor sleep quality had a significantly higher body fat percentage compared with those with good sleep quality ($p = 0.003$). In contrast, years of sports participation, body density, and daily training duration were significantly higher among athletes with good sleep quality ($p < 0.05$) (Table 3).

Table 3. Comparison of anthropometric and training characteristics according to diet quality and sleep quality.

Diet Quality				Sleep Quality			
Variable	Poor	Moderate	Good	TEST	Good	Poor	TEST
BMI (kg/m ²)	21.72±0.98	21.73±2.02	20.83±2.76	F = 0.239; p = 0.792	21.72±1.92	20.81±2.86	t = 0.979; p = 0.330
Body weight (kg)	71.50(6.5)	71.0(12.25)	68.0(26.5)	χ^2 = 2.576; p = 0.276	72.84±11.55	69.80±1.13	t = 0.209; p = 0.835
Body fat percentage (%)	8.58(2.18)	9.26(5.70)	12.0(3.91)	χ^2 = 3.901; p = 0.142	10.07±3.80	14.83±2.00	t = -4.811; p = 0.003
Body density (g/cm ³)	1.07(0.01)	1.07(0.01)	1.06(0.01)	χ^2 = 2.204; p = 0.332	1.07±0.009	1.06±0.004	t = 4.862; p = 0.003
Years of sports participation (years)	10.0(1.25)	10.0(4.25)	11.0(11.0)	χ^2 = 1.869; p = 0.393	11.26±4.80	8.00 ± 1.73	t = 3.470; p = 0.008
Weekly training (days/week)	5.0(1.25) ^b	6.0(2.0) ^b	7.0(4.0) ^a	χ^2 = 14.113; p = 0.001	5.85 ± 1.07	6.40 ± 0.89	t = -1.302; p = 0.253
Daily training duration (hours/day)	2.0(0.25) ^b	2.0(1.0) ^b	3.00(1.0) ^a	χ^2 = 9.179; p = 0.010	3.40 ± 0.89	2.65 ± 0.76	t = -2.090; p = 0.040
Sport discipline (n)							
Football	10	45	0	χ^2 : 14.911 p=0.005	54	1	χ^2 : 7.621 p=0.022
Volleyball	0	20	4		20	4	
Basketball	0	9	1		10	0	

BMI: Body Mass Index; t: Independent samples t-test; χ^2 : Chi-squared test; χ^2 : Kruskal–Wallis test; F: One-way ANOVA. ^{ab} Different superscript letters indicate significant differences between groups. Values are expressed as Median (IQR) for Diet Quality groups and Mean ± SD for Sleep Quality groups.

When energy and macronutrient intakes were compared according to diet and sleep quality, protein and fat intake differed significantly across diet quality categories ($p < 0.05$), whereas no significant differences were observed according to sleep quality ($p > 0.05$) (Table 4).

Table 4. Distribution of energy and macronutrient adequacy according to diet quality and sleep quality.

Variables		Diet Quality n (%)			TEST	Sleep Quality n (%)		TEST
		Poor	Moderate	Good		Good	Poor	
Energy	Insufficient	6 (60.0)	33 (44.6)	1 (20.0)	χ^2 : 2.181	39 (80.0)	1 (20.0)	χ^2 :1.333
	Adequate	4 (40.0)	41 (55.4)	4 (80.0)	p= 0.337	45 (53.6)	4 (80.0)	p=0.248
	Excessive	0 (0.00)	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	
Protein	Insufficient	3 (30.0)	5 (6.8)	0 (0.00)	χ^2 : 10.911	8 (9.5)	0 (0.00)	χ^2 :0.562
	Adequate	5 (50.0)	55 (74.3)	2 (40.0)	p= 0.028	58 (69.0)	4 (80.0)	p=0.755
	Excessive	2 (20.0)	14 (18.9)	3 (60.0)		18 (21.4)	1 (20.0)	
Fat	Insufficient	2 (20.0)	4 (5.4)	1 (20.0)	χ^2 : 19.013	7 (8.3)	0 (0.00)	χ^2 :0.454
	Adequate	8 (80.0)	57 (77.0)	0 (0.00)	p= 0.001	61 (72.6)	4 (80.0)	p=0.797
	Excessive	0 (0.00)	13 (17.6)	4 (80.0)		16 (19.0)	1 (20.0)	
Carbohydrate	Insufficient	10 (100.0)	72 (97.3)	5 (100.0)	χ^2 : 0.415	82 (97.6)	5(100.0)	χ^2 :0.122
	Adequate	0 (0.00)	2 (2.7)	0 (0.00)	p= 0.813	2 (2.4)	0 (0.00)	p=0.727
	Excessive	0 (0.00)	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	

χ^2 : Pearson's chi-squared test

Diet quality differed significantly according to self-reported nutrition knowledge ($p=0.034$) and the use of sleep-support supplements ($p=0.014$). Regarding sleep quality, significant differences were observed according to smoking status ($p=0.017$) and the use of sleep-support supplements ($p=0.041$).

Correlation analyses revealed a weak but significant positive association between sleep quality score and body fat percentage ($r=0.293$, $p<0.05$). Body mass index was negatively associated with body fat percentage ($r= -0.125$, $p<0.05$), while body density showed a strong negative correlation with body fat percentage ($r= -0.979$, $p<0.05$) (Table 5).

Table 5. Correlations between anthropometric characteristics, sleep quality, and diet quality.

	Sleep Quality	Diet Quality	Body Weight	BMI	Body Fat Percentage	Body Density
Sleep Quality	1					
Diet Quality	-0.082	1				
Body Weight	-0.067	0.068	1			
BMI	-0.114	0.024	0.817*	1		
Body Fat Percentage	0.293*	0.061	-0.205	-0.125	1	
Body Density	-0.294*	-0.038	0.230*	0.156	-0.979*	1

BMI: Body Mass Index * $p < 0,05$ Pearson correlation

Discussion

This study examined the associations between diet quality, sleep quality, and body composition in professional athletes. The results from this research revealed several relevant findings related to sleep, nutrition and body composition as interacting elements of professional athletes. Although there was no direct correlation between diet quality and sleep quality, both factors were strongly related to a few factors, therefore indicating that many different factors may exist that affect the level of sleep quality found in athletes rather than a single determinant.

While athletes in the present study exhibited predominantly moderate diet quality and adequate sleep quality, no statistically significant relationship was found between diet quality and sleep quality. This outcome aligns with previous literature reporting variable and inconsistent findings regarding the overall impact of dietary patterns on sleep parameters in athletic populations^{9,15}. One explanation for this lack of significant relationships may be attributed to the existence of well-structured routines, scheduled training, and recovery protocols that most professional athletes maintain, which help alleviate many of the adverse consequences associated with an individual having a suboptimal dietary pattern on his/her sleep. In addition, the relatively small number of individuals who exhibited low-quality sleep may limit the insight into the amount of strength of association that exists in this cohort. Moreover, the HEI-2015 may not fully reflect traditional Aegean/ Mediterranean dietary patterns (e.g., olive oil and fresh greens), representing a potential cultural measurement constraint in this cohort. Athletes in the 'Good' dietary quality group exhibited a higher weekly training frequency and longer daily training duration than those in the 'Poor' group. These findings suggest that greater athletic dedication and overall training volume are positively associated with superior dietary adherence.

The results suggest that athletes who train more intensively tend to be more knowledgeable about nutrition and have stronger commitment to nutrition when using sports-orientated methods. As a result of the increased energy demands placed on them, as well as their need to recover quickly and keep their body composition stable, these athletes may give special consideration to adequate nutrition. The findings are consistent with previous research, which has shown an association between training volume and diet quality in elite level athletes^{11,12}. In addition, the differences in protein and fat intake according to diet quality categories support the idea that higher diet quality means that macronutrients are more evenly distributed, which is an integral part of the athlete-specific nutrition guidelines^{6,8}. Also, over 97% of the athletes were classified as having insufficient carbohydrate intake based on the ACSM guidelines. In athletic populations, such high rates of insufficient intake are frequently attributed to behavioral patterns, including regular meal skipping or inadequate fueling timing around training sessions. Additionally, methodological constraints of self-reported dietary intake tools, along with periodized sports training timing, contributed to this finding^{16,23}. Additionally, sleep quality has been found to be significantly related to several measures of body composition. Athletes with poor sleep quality have a greater percentage of body fat, while those with good sleep quality have more body density and a longer duration of training experience. While metabolic and hormonal pathways—such as alterations in leptin, ghrelin, cortisol, and growth hormone—are often implicated in fat metabolism and recovery^{14,17}, the cross-sectional nature of our study design precludes establishing a definitive causal direction. It is equally plausible that higher body adiposity negatively impacts sleep architecture through mechanisms such as low-grade systemic inflammation or subclinical sleep-disordered breathing. Therefore, this association should be interpreted as bidirectional, where poor sleep quality and elevated body fat may mutually reinforce each other. Higher levels of training experience and greater body density in athletes who obtain adequate amounts of restful sleep suggest that they have more efficient recovery processes as well as have adapted more effectively to the training stressor over a period which was also documented in the findings of previous research reviews⁴.

Current correlation analysis demonstrated a positive association, with a weak level of significance, between the athletes' sleep quality scores and body fat percentages. On the surface, this may seem illogical but there are plausible explanations for this finding. It is likely that the correlation between sleep quality score and body fat percentage reflects the directionality of how we have rated sleep quality on this scale. That is, the higher the sleep quality score indicates poorer sleeping habits. Therefore, if a higher sleep quality score (indicating that the athlete did not sleep well) corresponds to a higher body fat percentage, this finding would be in line with other relevant literature that links poor sleeping habits with negative body composition outcomes^{14,16}. Additionally, there is a very strong inverse correlation between body density and body fat percentage. This finding supports the validity of the measurements used to classify body composition in this investigation.

Another factor associated with athletes' sleep patterns was their lifestyle, especially smoking. As expected, people who smoke experience more poor-quality sleep than people who do not smoke. This matches previous research that shows nicotine acts as a stimulant and negatively impacts how the brain works while you are asleep, with the result that people who smoke have greater difficulty staying asleep¹. Quality of sleep and nutritional quality varied based on whether or not an athlete was taking sleep-support supplements, indicating that athletes who are using sleep-support supplements may have a greater awareness of the importance of using recovery strategies or may have underlying sleep issues; this is consistent with findings from studies examining use of supplements among elite level athletes^{9,10}.

The current findings are consistent with previous research investigating types of sleep in athletic populations. Results have shown that duration, efficiency, and architecture of sleep are dependent on an athlete's level of expertise, the time of year (season), and the amount of training that they are doing. Therefore, the quality of sleep, along with these three factors, directly influences both recovery and performance outcomes for athletes²⁴. Comprehensive reviews have also shown that poor quality of sleep and inadequate sleep duration have consistently been shown to be detrimental to athletes across various sports, affecting both their physical performance, injury risk, and recovery time²⁵.

When interpreting the relationship between body composition parameters and sleep quality, the potential influence of the uneven sex distribution (73% male vs. 27% female) in our sample must be considered. Although sex-specific Jackson-Pollock equations were applied to accurately calculate body density and fat percentage, biological differences between sexes extend beyond anthropometric formulas. Hormonal fluctuations across the menstrual cycle in female athletes can influence fluid retention, energy metabolism, and body composition dynamics. Furthermore, sex-specific variations in circadian rhythms and sleep architecture may modulate -how sleep quality interacts with metabolic health^{26,27}. Given the male-dominated nature of our cohort, the present findings primarily reflect the physiological dynamics of male athletes and may not fully capture sex-specific interactions in female athletic populations.

There are several multi-dimensional variables that could be the underlying mechanisms responsible for the association of sleep quality, body composition, and training variables in our study. Collectively, our results indicate that although diet may not be the sole determinant of sleep quality in male and female professional athletes, it does exert one of the strongest influences on sleep quality because of how it affects their training volume and loads, as well as their overall body composition and mechanics. It is also vital to examine sleep, nutrition, and body composition using a multi-dimensional framework to understand how these variables interact with each other. Therefore, these findings further support the need for an integrated multi-dimensional approach to athlete health and performance rather than just focusing on single behavior assessments^{13,15}.

Conclusion

This cross-sectional study evaluated the associations of diet quality and body composition with sleep quality in professional athletes. The findings showed no significant association between overall diet quality and sleep quality; however, poorer sleep quality was associated with higher body fat percentage and less favorable body composition parameters. Diet quality was significantly influenced by training duration, nutrition knowledge, and the use of sleep-support supplements, emphasizing the multifactorial nature of dietary behaviors in athletes. These results suggest that sleep quality, diet quality, and body composition should be considered together rather than in isolation when evaluating health and performance in professional athletes. Further longitudinal and interventional studies are needed to clarify causal relationships and underlying mechanisms.

Limitations

This study has several limitations. Its cross-sectional design precludes causal inference. The sample was predominantly male and limited to specific sports and clubs within a single region, which may reduce generalizability. Dietary intake and sleep quality were assessed using self-reported measures, potentially introducing recall bias. Additionally, indirect body composition assessment methods were used. Furthermore, using the HEI-2015 may not fully capture traditional Aegean/Mediterranean dietary patterns, representing a cultural assessment constraint. Although all skinfold measurements were carefully performed by a single trained researcher taking triplicate readings to ensure consistency, a formal intra-rater reliability analysis (such as the Intraclass Correlation Coefficient) was not conducted prior to data collection, which represents a methodological limitation. Finally, some potential confounding factors, such as psychological stress and training intensity, were not fully controlled.

Acknowledgements

This study is derived from the master's thesis of GSP, conducted under the supervision of MY at Izmir Tinaztepe University in Turkey. The authors would like to express their gratitude to the athletes and coaching staff who participated in this study for their time and cooperation.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

Declarations of Interest

None.

REFERENCES

1. Vitale KC, Owens R, Hopkins SR, Malhotra A. Sleep hygiene for optimizing recovery in athletes: review and recommendations. *Int J Sports Med*. 2019;40(08):535-543.
2. Garbarino S, Lanteri P, Bragazzi NL, Magnavita N, Scoditti E. Role of sleep deprivation in immune-related disease risk and outcomes. *Commun Biol. Nature Research*. 2021;4(1).
3. Cook JD, Charest J. Sleep and performance in professional athletes. *Curr Sleep Med Rep*. 2023;9(1):56-81. doi: 10.1007/s40675-022-00243-4
4. Kaczmarek F, Bartkowiak-Wieczorek J, Matecka M, et al. Sleep and athletic performance: a multidimensional review of physiological and molecular mechanisms. *J Clin Med. Multidisciplinary Digital Publishing Institute (MDPI)*. 2025;14(21).
5. Binks H, Vincent GE, Gupta C, Irwin C, Khalesi S. Effects of diet on sleep: A narrative review. *Nutrients. Multidisciplinary Digital Publishing Institute (MDPI)*. 2020;12(4).
6. Du C, Almotawa J, Feldpausch CE, Folk SYL, Parag H, Tucker RM. Effects of macronutrient intake on sleep duration and quality: A systematic review. *Nutrition & Dietetics*. 2022;79(1):59-75. doi: 10.1111/1747-0080.12671
7. Huang L, Jiang Y, Sun Z, et al. Healthier dietary patterns are associated with better sleep quality among shanghai suburban adults: a cross-sectional study. *Nutrients*. 2024;16(8).
8. Koikawa N, Minamino Y, Kawasaki Y, Kasai T, Suzuki Y. The impact of macronutrient intake on sleep quality in female endurance athletes: a pilot observational cross-sectional study. *Nutrients* . 2025;17(8). doi: 10.3390/nu17081368
9. Gratwicke M, Miles KH, Pyne DB, Pumpa KL, Clark B. Nutritional interventions to improve sleep in team-sport athletes: A narrative review. *Nutrients. MDPI AG*. 2021;13(5).
10. Rackard G, Madigan SM, Connolly J, Keaver L, Ryan L, Doherty R. Nutrition strategies to promote sleep in elite athletes: a scoping review. *Sports. Multidisciplinary Digital Publishing Institute (MDPI)*. 2025;13(10). doi: 10.3390/sports13100342
11. Capling L, Tam R, Beck KL, et al. Diet quality of elite australian athletes evaluated using the athlete diet index. *Nutrients*. 2021;13(1):1-16. doi: 10.3390/nu13010126

12. Dion S, Walker G, Lambert K, Stefoska-Needham A, Craddock JC. The diet quality of athletes as measured by diet quality indices: a scoping review. *Nutrients. Multidisciplinary Digital Publishing Institute (MDPI)*. 2025;17(1). doi: 10.3390/nu17010089
13. Bazzani A, Faraguna U. Eat Well, Sleep well: exploring the association between eating behavior and sleep quality. *Nutrient. Multidisciplinary Digital Publishing Institute (MDPI)*. 2025;17(17). doi: 10.3390/nu17172908
14. Kitamura E, Kawasaki Y, Kasai T, et al. The relationship between body composition and sleep architecture in athletes. *Sleep Med*. 2021;87:92-96. doi: 10.1016/j.sleep.2021.08.028
15. Barnard J, Roberts S, Lastella M, Aisbett B, Condo D. The impact of dietary factors on the sleep of athletically trained populations: a systematic review. *Nutrients. MDPI*. 2022;14(16).
16. Alarcón-Rivera M, Montecino-Rojas F, Guzmán-Muñoz E, et al. Analysis of sleep quality and its impact on body composition on the pre-competition day in natural bodybuilders. *Retos*. 2025;66:395-402. doi: 10.47197/retos.v66.111445
17. Watson AM. Sleep and athletic performance. *Curr Sports Med Rep*. 2017;16(6):413-418.
18. Mei M, Zhou Q, Gu W, et al. Dietary supplement interventions and sleep quality improvement: a systematic review and meta-analysis. *Nutrients. Multidisciplinary Digital Publishing Institute (MDPI)*. 2025;17(24). doi: 10.3390/nu17243952
19. Jackson AS, Pollock ML. Practical assessment of body composition. *Phys Sportsmed*. 1985;13(5):76-90. doi: 10.1080/00913847.1985.11708790
20. Siri WE. Body composition from fluid spaces and density: Analysis of methods. In: *Techniques for Measuring Body Composition*. 1961:223-244.
21. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4
22. U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee Part D, Chapter 8*. 2020.
23. American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Wolters Kluwer; 2016.

- 24.** Vlahoyiannis A, Aphasimis G, Bogdanis GC, Sakkas GK, Andreou E, Giannaki CD. Deconstructing athletes' sleep: A systematic review of the influence of age, sex, athletic expertise, sport type, and season on sleep characteristics. *J Sport Health Sci.* 2021;10(4):387-402. doi: 10.1016/j.jshs.2020.03.006
- 25.** Charest J, Grandner MA. Sleep and athletic performance. *Sleep Med Clin.* 2020;15(1):41-57.
- 26.** Elliott-Sale KJ, Flood TR, Arent SM, Dolan E, Saunders B, Hansen M, et al. Effect of menstrual cycle and contraceptive pill phase on aspects of exercise physiology and athletic performance in female athletes: protocol for the Feminae international multisite innovative project. *BMJ Open Sport Exerc Med.* 2023;9(4):e001814.
- 27.** Mong JA, Cusmano DM. Sex differences in sleep: impact of biological sex and sex steroids. *Philos Trans R Soc Lond B Biol Sci.* 2016;371(1688):20150110.

Evaluation of Vegetarian and Vegan Menus Served in University Cafeterias in Terms of Nutritional Value

Bahar YALÇIN ÇELİKTAŞ*, Muazzez GARİPAĞAOĞLU**, İlayda KOÇAK***, Misline GEYİK****

Abstract

Aim: This study aimed to evaluate the planned lunch menus of two state universities in İzmir and Istanbul that offer vegan and vegetarian options through a theoretical analysis of energy and nutrient content.

Method: In this descriptive study, one-month (29-day) lunch menus obtained from official university websites were analysed for food groups, energy, and nutrient content. Nutrient values were calculated using standard institutional recipes in the Nutrition Information System (BEBIS) 9.0 and compared with the Turkish Nutrition Guide (TUBER) 2022 to assess lunch-level energy and nutrient adequacy. The analysis reflects theoretical values based on planned menus rather than actual served portions or consumption.

Results: The non-vegetarian menu of University B contained higher levels of dietary fibre, vitamins C, B1, B6, B12, iron, zinc, and sodium than University A. In vegetarian menus, University B showed higher values of dietary fibre, vitamins C, B1, B2, B6, and sodium, whereas the vegan menu of University A contained higher energy and fat levels. According to the reference framework used, vegetarian menus appeared to meet most nutrient requirements except vitamin B12, while vitamin B12 and calcium remained below the reference range in vegan menus.

Conclusion: This theoretical analysis suggests that vegetarian menus generally align with lunch-level nutrient recommendations and that appropriately planned vegetarian and vegan menus may provide nutritionally adequate meal options, whereas potential insufficiencies in vitamin B12 and calcium may exist in vegan menus. These findings should be interpreted within the context of planned menus rather than actual consumption.

Keywords: Nutrients, menu planning, vegan, vegetarian.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 11.11.2024 Kabul / Accepted: 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1583037>

* Dr., Fenerbahçe University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye.

E-mail: bahar.yalcin@fbu.edu.tr [ORCID https://orcid.org/0000-0003-4036-7096](https://orcid.org/0000-0003-4036-7096)

** Prof. Dr., Fenerbahçe University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye.

E-mail: muazzez.garipagaoglu@fbu.edu.tr [ORCID https://orcid.org/0000-0003-2172-1467](https://orcid.org/0000-0003-2172-1467)

*** Undergraduate Student, Fenerbahçe University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: ilaydako1401@gmail.com [ORCID https://orcid.org/0009-0008-5436-8448](https://orcid.org/0009-0008-5436-8448)

**** Undergraduate Student, Fenerbahçe University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: dyt.mislina@gmail.com [ORCID https://orcid.org/0009-0000-5318-9263](https://orcid.org/0009-0000-5318-9263)

Üniversite Yemekhanelerinde Sunulan Vejetaryen ve Vegan Menülerin Besin Değeri Açısından Değerlendirilmesi

Öz

Amaç: Bu çalışmanın amacı, İzmir ve İstanbul'da vegan ve vejetaryen seçenekler sunan iki devlet üniversitesinin planlanmış öğle yemeği menülerini enerji ve besin öğeleri açısından teorik olarak değerlendirmektir.

Yöntem: Tanımlayıcı tipteki bu çalışmada, üniversitelerin resmî internet sitelerinden elde edilen bir aylık (29 günlük) öğle yemeği menüleri besin grupları, enerji ve besin öğeleri açısından analiz edilmiştir. Besin ögesi değerleri, Beslenme Bilgi Sistemi (BEBİS) 9.0 programındaki standart kurum tarifleri kullanılarak hesaplanmış ve öğle öğününe ilişkin enerji ve besin ögesi yeterliliğini değerlendirmek amacıyla Türkiye Beslenme Rehberi (TÜBER) 2022 ile karşılaştırılmıştır. Analiz, gerçek porsiyonlar veya tüketim yerine planlanmış menülere dayalı teorik değerleri yansıtmaktadır. Veriler IBM SPSS yazılımı kullanılarak analiz edilmiştir.

Bulgular: B Üniversitesi'nin vejetaryen olmayan menüsü, A Üniversitesi'ne kıyasla daha yüksek diyet lifi, C, B1, B6, B12 vitaminleri, demir, çinko ve sodyum içermektedir. Vejetaryen menülerde B Üniversitesi'nin diyet lifi, C, B1, B2, B6 vitaminleri ve sodyum değerleri daha yüksek bulunurken, A Üniversitesi'nin vegan menüsünde enerji ve yağ içeriği daha yüksektir. Kullanılan referans çerçevesine göre, vejetaryen menülerin B12 vitamini dışında çoğu besin ögesi açısından gereksinimleri karşıladığı; vegan menülerde ise B12 vitamini ve kalsiyumun referans aralığın altında kaldığı belirlenmiştir.

Sonuç: Bu teorik analiz, vejetaryen menülerin genel olarak öğle öğünü besin ögesi önerileri ile uyumlu olduğunu ve uygun şekilde planlandığında vejetaryen ve vegan menülerin beslenme açısından yeterli öğün seçenekleri sunabileceğini; ancak vegan menülerde B12 vitamini ve kalsiyum açısından potansiyel yetersizlikler bulunabileceğini göstermektedir. Bu bulguların, gerçek tüketimden ziyade planlanmış menüler bağlamında değerlendirilmesi gerekmektedir.

Anahtar Sözcükler: Besin ögesi, menü planlama, vegan, vejetaryen.

Introduction

Vegetarian and vegan diets have been adopted by many cultures and societies throughout history and have been considered safe and nutritious as a long-term diet. These diets have been claimed to have some benefits for human health and have been reported to serve ethical and sustainability principles such as environmental and animal protection¹. At the same time, vegetarian and vegan diets are considered to be more sustainable than diets based on animal products because they use fewer natural resources and produce lower greenhouse gas emissions². Vegetarianism, which has become increasingly popular in recent years, has types such as vegan where all animal foods are excluded, lacto-vegetarian where only dairy products are consumed except meat-fish and eggs, ovo-vegetarian where only eggs are consumed except meat-fish and milk, lacto-ovo-vegetarian where eggs and dairy products are consumed except meat-fish, and pescetarian where only fish and seafood are consumed instead of meat³. In recent years, there has been a significant increase in the number of individuals with vegetarian and vegan eating habits in many countries of the world, especially in developed countries. It

is estimated that approximately 10% of the general adult population follows a vegetarian diet and 1-2% follows a vegan diet⁴.

Scientific studies have shown that vegetarian and vegan diets offer various health benefits such as lower body mass index (BMI), lower blood pressure, and prevention and treatment of non-communicable diseases^{5,6}. However, it has been stated that vegetarian diets can negatively affect health due to micronutrient deficiencies, but can positively affect health when well planned⁷. In terms of sustainability, it has been noted that vegetarian and vegan diets have a lower carbon footprint⁸ and the ecological footprint as well as the water footprint is three times lower compared to non-vegetarian diets⁹.

Today, in parallel with the increasing interest in vegetarian diets, which stand out with their health and environmental benefits, more vegetarian options are offered in the menus of institutions and organisations, including restaurants, factories, banks, schools, and universities². This development is considered an important practice in terms of improving the accessibility and adoption of vegetarian and vegan diets by a wider population. A review of the literature identified a limited number of studies examining the health benefits of vegetarian diets in Türkiye^{10,11}, but no studies evaluating the nutritional composition of vegetarian and vegan university cafeteria menus were found. Therefore, this study was conducted to evaluate the nutritional values of vegetarian and vegan menus served in university cafeterias. This study aims to contribute to the limited literature by evaluating the adequacy of these menus in terms of energy and nutrient content and by providing evidence that may help improve future menu planning practices.

Material and Methods

This descriptive menu analysis study evaluated one-month (29-day) non-vegetarian, vegetarian, and vegan lunch menus for February 2024 from two public universities in İzmir and Istanbul that offer vegan and vegetarian options. The menus were obtained from the official websites of the universities. These institutions were selected because they were among the limited public universities in Turkey providing complete and accessible monthly lunch menus that included both vegetarian and vegan options. Universities from two different cities were chosen to reflect regional diversity, while only public universities were included to ensure comparability in food service practices. University menus were labelled as A and B. The comparison aimed to explore differences in menu composition across institutional settings rather than provide generalisable results.

The menus were evaluated in terms of food groups, energy, and nutrient content. Energy and nutrient values were calculated using standard institutional recipes in the Nutrition Information System (BEBIS) 9.0 full version. During calculations, meal portions were considered as standard medium portions, yoghurt as 150 mL, and ayran as 200 mL. This study represents a theoretical menu analysis based on planned menus and standard institutional recipes; therefore, it does not reflect actual served portions, recipe variations, plate waste, or student consumption.

The calculated values were compared with the reference intake ranges for adults specified in the Turkish Nutrition Guide (TUBER) 2022. In order to meet daily energy and nutrient requirements, it is recommended to consume three main meals and 1–3 snacks throughout the day¹². In collective food service systems, lunch is commonly considered one of the main meals and is expected to provide approximately 2/5 of daily energy and nutrient requirements according to national menu planning guidelines¹³. However, this distribution may vary across institutions and should be interpreted as a planning reference rather than an absolute standard. The adequacy of nutrient intake was classified as <66% insufficient, 66–133% sufficient, and >133% excessive consumption¹⁴.

Data were analysed using IBM SPSS for Windows Version 26.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics (mean, standard deviation, and variance) were calculated for all variables. Each daily menu was treated as an independent observation, and mean nutrient values were compared between universities within each menu type using one-way analysis of variance (ANOVA). Prior to analysis, normality was assessed using the Shapiro–Wilk test and homogeneity of variances was evaluated using Levene’s test. Statistical significance was accepted as $p < 0.05$. Since multiple nutrients were tested separately, the possibility of type I error should be considered when interpreting statistically significant findings. As the data are based on consecutive daily menu plans, results should also be interpreted with caution. Since the study was conducted using publicly available menu data and did not involve human participants, ethics committee approval was not required.

Limitations of the Study

This study has several limitations. First, the analysis was based on planned menus and standard recipes, and therefore reflects theoretical nutrient values rather than actual food served or consumed. Variations in portion sizes, food preparation methods, ingredient substitutions, and plate waste were not accounted for. Second, only lunch menus were evaluated, and total daily dietary intake could not be assessed. Third, the study covered a single one-month menu cycle, limiting the ability to evaluate long-term nutritional adequacy and menu variability. Fourth, the sample was limited to two public universities, which restricts the generalisability of the findings. Finally, as multiple nutrients were analysed separately, there is a potential risk of type I error in the statistical comparisons.

Results

The energy and nutrient contents of the university menus are summarised in Table 1. It was determined that dietary fibre, vitamin C, B1, B6, B12, iron, zinc, and sodium contents of the non-vegetarian menu of University B were significantly higher than those of University A ($p < 0.05$). No significant differences were observed for other nutrients. In vegetarian menus, dietary fibre, vitamin C, B1, B2, B6, and sodium values were significantly higher in University B compared to University A ($p < 0.05$). In vegan menus, the energy and fat contents of the menu at University A were significantly higher than

those of University B ($p < 0.05$). As expected, cholesterol was absent in vegan menus and lower in vegetarian menus than in non-vegetarian menus.

Table 1. Energy and nutrient contents of lunch menus served at universities.

Energy and Nutrients	Non-vegetarian Menu			Vegetarian Menu			Vegan Menu		
	A X $\pm$ SD	B X $\pm$ SD	P*	A X $\pm$ SD	B X $\pm$ SD	P*	A X $\pm$ SD	B X $\pm$ SD	P*
Energy (kcal)	935.0 $\pm$ 185.9	977.6 $\pm$ 190.4	0.393	917.2 $\pm$ 206.6	874.4 $\pm$ 142.8	0.363	904.1 $\pm$ 37.9	804.6 $\pm$ 158.8	0.043
Carbohydrate (g)	116.8 $\pm$ 25.1	114.9 $\pm$ 20.4	0.755	119.3 $\pm$ 30.6	116.2 $\pm$ 22.7	0.666	122.1 $\pm$ 26.2	11.4 $\pm$ 25.4	0.158
Carbohydrate (%)	51.4 $\pm$ 6.5	48.6 $\pm$ 5.8	0.082	53.2 $\pm$ 6.6	54.3 $\pm$ 4.2	0.439	55.6 $\pm$ 7.5	57.0 $\pm$ 5.4	0.415
Fiber (g)	10.8 $\pm$ 3.4	13.6 $\pm$ 4.2	0.010	13.3 $\pm$ 1.2	15.8 $\pm$ 5.8	0.058	16.0 $\pm$ 5.2	16.1 $\pm$ 5.6	0.938
Protein (g)	35.9 $\pm$ 12.7	39.5 $\pm$ 9.4	0.231	27.6 $\pm$ 7.5	26.6 $\pm$ 6.0	0.604	22.3 $\pm$ 5.5	23.0 $\pm$ 5.9	0.651
Protein (%)	15.8 $\pm$ 5.0	16.6 $\pm$ 2.7	0.497	12.3 $\pm$ 2.3	12.5 $\pm$ 2.6	0.676	10.1 $\pm$ 2.3	11.9 $\pm$ 2.9	0.011
Fat (g)	34.7 $\pm$ 11.1	38.6 $\pm$ 12.2	0.208	35.5 $\pm$ 11.1	32.3 $\pm$ 6.9	0.186	35.6 $\pm$ 15.1	27.9 $\pm$ 7.7	0.019
Fat (%)	32.7 $\pm$ 5.9	34.7 $\pm$ 5.8	0.201	34.5 $\pm$ 6.7	33.0 $\pm$ 4.9	0.333	34.2 $\pm$ 8.5	31.2 $\pm$ 6.1	0.120
Cholesterol (mg)	121.1 $\pm$ 60.9	134.7 $\pm$ 75.1	0.451	73.3 $\pm$ 56.3	66.4 $\pm$ 49.7	0.621	-	-	-
PUFA (g)	6.9 $\pm$ 3.7	8.5 $\pm$ 4.6	0.163	8.2 $\pm$ 4.5	8.6 $\pm$ 4.1	0.762	9.4 $\pm$ 5.4	8.3 $\pm$ 3.5	0.374
Vitamin A (μ g)	494.8 $\pm$ 272.5	978.7 $\pm$ 568.0	<0.001	612.2 $\pm$ 454.8	941.7 $\pm$ 445.8	0.007	890.7 $\pm$ 728.6	952.4 $\pm$ 440.5	0.698
Vitamin E (mg)	5.07 $\pm$ 4.2	6.7 $\pm$ 4.7	0.168	7.3 $\pm$ 4.6	6.5 $\pm$ 4.6	0.508	7.9 $\pm$ 5.2	5.7 $\pm$ 3.6	0.062
Vitamin C (mg)	39.1 $\pm$ 27.6	58.5 $\pm$ 30.5	0.014	55.5 $\pm$ 29.8	78.1 $\pm$ 43.0	0.024	73.8 $\pm$ 38.8	77.7 $\pm$ 42.9	0.716
Vitamin B1 (mg)	0.4 $\pm$ 0.1	0.5 $\pm$ 0.1	0.001	0.4 $\pm$ 0.1	0.5 $\pm$ 0.2	0.040	0.5 $\pm$ 0.2	0.5 $\pm$ 0.2	0.718
Vitamin B2 (mg)	0.6 $\pm$ 0.1	0.6 $\pm$ 0.2	0.828	0.5 $\pm$ 0.1	0.4 $\pm$ 0.1	0.050	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1	0.568
Vitamin B6 (mg)	0.6 $\pm$ 0.1	0.8 $\pm$ 0.2	<0.001	0.6 $\pm$ 0.1	0.7 $\pm$ 0.1	<0.001	0.6 $\pm$ 0.2	0.7 $\pm$ 0.2	0.059
Vitamin B12 (μ g)	1.9 $\pm$ 1.4	3.3 $\pm$ 2.9	0.036	0.7 $\pm$ 0.5	0.4 $\pm$ 0.3	0.012	0.0 $\pm$ 0.1	0.0 $\pm$ 0.1	0.959
Calcium (mg)	344.1 $\pm$ 116.9	297.2 $\pm$ 111.4	0.124	349.7 $\pm$ 108.5	295.4 $\pm$ 112.8	0.067	190.9 $\pm$ 60.7	204.9 $\pm$ 60.6	0.383
Phosphorus (mg)	559.5 $\pm$ 144.8	578.4 $\pm$ 117.9	0.587	521.39 $\pm$ 110.02	483.4 $\pm$ 121.7	0.217	411.3 $\pm$ 133.3	391.7 $\pm$ 116.4	0.554
Magnesium (mg)	139.0 $\pm$ 40.4	157.8 $\pm$ 41.2	0.084	152.2 $\pm$ 38.3	157.9 $\pm$ 46.4	0.612	158.3 $\pm$ 48.0	148.4 $\pm$ 45.4	0.424
Sodium (mg)	1959.5 $\pm$ 633.2	2437.2 $\pm$ 848.1	0.018	1918.2 $\pm$ 537.4	2303.9 $\pm$ 688.8	0.021	1954.0 $\pm$ 978.2	1946.5 $\pm$ 619.8	0.972
Iron (mg)	5.2 $\pm$ 2.1	6.6 $\pm$ 2.0	0.012	5.6 $\pm$ 2.0	5.8 $\pm$ 2.0	0.605	6.0 $\pm$ 2.1	5.7 $\pm$ 2.0	0.528
Zinc (mg)	4.9 $\pm$ 1.7	6.4 $\pm$ 1.9	0.004	4.1 $\pm$ 1.2	3.8 $\pm$ 0.9	0.490	3.6 $\pm$ 1.2	3.5 $\pm$ 1.0	0.699

Anova test, * $p < 0,05$

The contents of the university menus according to food groups are summarised in Table 2. In non-vegetarian menus, dairy products (milk, yoghurt, and cheese) and animal-based protein sources such as red meat, chicken, fish, and eggs were included. Vegetarian menus contained dairy products, eggs, and higher amounts of legumes compared to non-vegetarian menus. Vegan menus did not include any animal-derived foods and consisted of plant-based food groups.

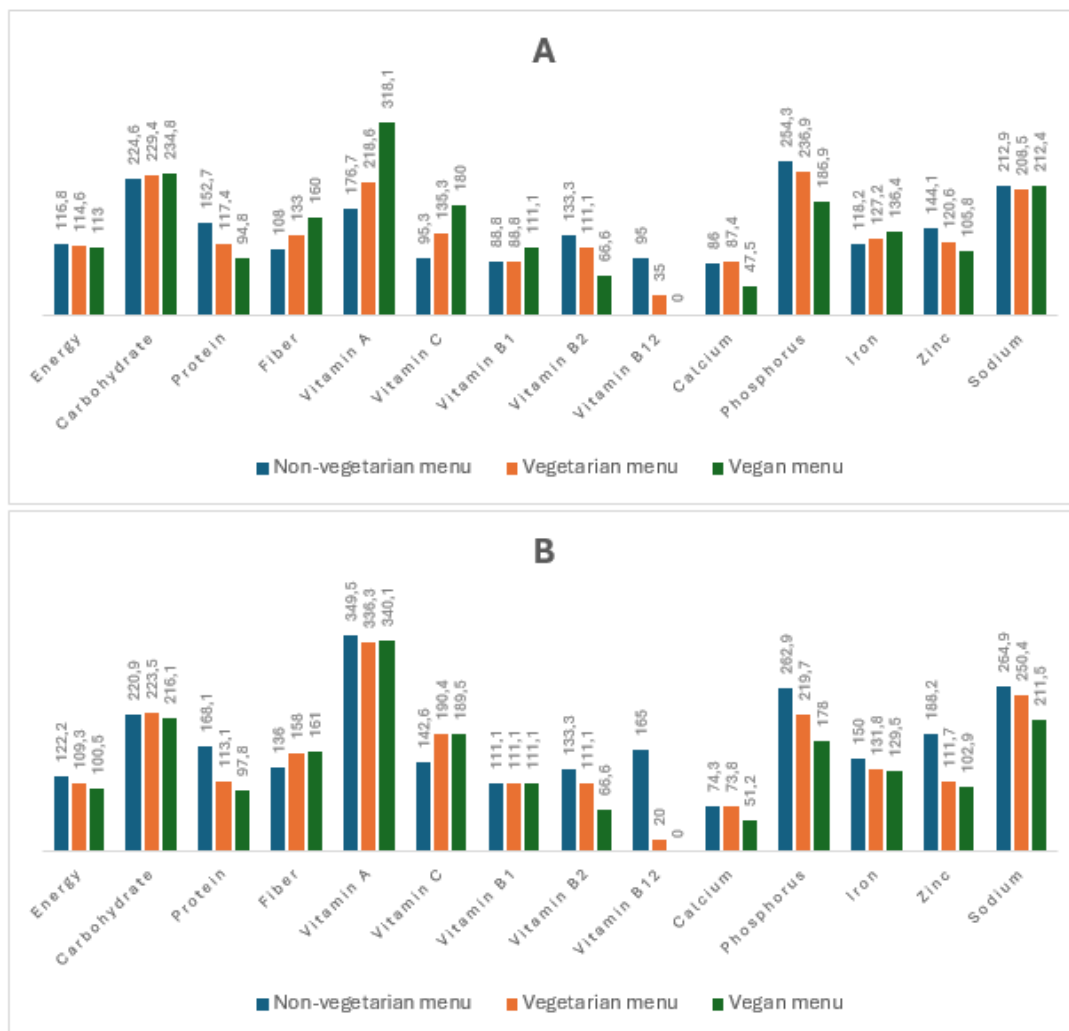
Table 2. Average daily amounts of food groups in planned lunch menus based on standard institutional recipes.

Food Groups	Non-vegetarian Menu		Vegetarian Menu		Vegan Menu	
	A	B	A	B	A	B
Milk and Products						
Milk (ml)	51.7	21	39	19.7	-	-
Yoghurt (g)	91.5	53.8	80	49.6	-	-
Cheese (g)	3.8	2.7	3.,9	1.7	-	-
Meat Group						
Red meat (g)	27.3	48.4	-	-	-	-
Chicken (g)	17.4	17.2	-	-	-	-
Fish (g)	5.2	5.2	-	-	-	-
Egg (g)	9.4	7.6	5.8	6	-	-
Legumes (g)	31.4	31.6	43	39	41.4	34.5
Bread and Cereals						
Bread (g)	56.5	60.9	54.4	55.6	57.5	52.4
Rice (g)	45.3	53.8	55.8	54.5	50	37.4
Bulgur (g)	7.5	9.5	12	8.4	18.5	8.1
Pasta (g)	22.6	25.2	25.7	25.5	17.1	27.4
Potato (g)	24.1	57.2	21.7	59.8	19.1	58.9
Flour (g)	22.5	13.1	16.9	11.8	9.7	14.6
Vegetables (g)	105.9	172.9	139	224.7	187	233.9
Fruit (g)	29.9	29.7	30.5	13.5	50.9	17.3
Oil (g)	24.5	29.7	27	30.2	32.6	31.4
Sugar (g)	11.9	8.2	11.1	8.4	10.9	8.2

Values are mean daily amounts based on planned menus in BEBIS and do not reflect actual consumption.

Figure 1 presents the percentage of meeting lunch-level nutrient requirements across menu types. According to the reference framework used in this study, most nutrients in non-vegetarian menus fell within the reference range. In vegetarian menus, most nutrients were within the reference range except for vitamin B12. In vegan menus, vitamin B12 and calcium values were below the reference range.

Figure 1. Percentage of lunch-level nutrient requirements met by menu types based on theoretical nutrient calculations.



Classification was defined as <66% (insufficient), 66–133% (adequate), and >133% (excessive).

Discussion

In this study, the nutritional values of one-month planned vegan, vegetarian, and non-vegetarian lunch menus of two state universities were analysed. The findings are based on theoretical calculations derived from standard recipes and therefore reflect menu

planning rather than actual consumption. Within the reference framework used in this study, most nutrients in vegetarian menus appeared to fall within the reference range, whereas vitamin B12 in vegetarian menus and both vitamin B12 and calcium in vegan menus remained below the reference range. Energy and protein values were generally within the expected range across all menu types. However, these results do not necessarily reflect long-term dietary intake or nutritional status.

In addition to these findings, the vegetarian and vegan menus demonstrated several favourable nutritional characteristics. They contained higher dietary fibre and lower cholesterol than the non-vegetarian menus, while energy and total protein values generally met the reference range across menu types. These findings suggest that appropriately planned plant-based menus may provide nutritionally adequate lunch options. Nevertheless, a previous study suggested that inadequately planned vegetarian, and particularly vegan, diets may be associated with nutrient inadequacies, including inadequate protein and calcium intake¹⁵. Although total protein values in the evaluated menus were within the reference range, concerns regarding protein quality and adequate protein intake in vegan diets have been reported¹⁶. In particular, Allès et al.¹⁷ reported that 27% of individuals following a vegan diet did not achieve the minimum recommended protein intake.

Protein quality was not assessed in this study; therefore, it should also be considered when evaluating the nutritional adequacy of vegan diets. Plant proteins generally have lower digestibility and a less favourable essential amino acid profile than animal proteins, partly because of plant cell walls and antinutritional compounds such as phytates, tannins, enzyme inhibitors, glucosinolates, and isothiocyanates^{16,18}. Therefore, potential limitations related to amino acid composition and digestibility should be acknowledged. Importantly, appropriate combinations of plant protein sources, particularly cereals and legumes, can provide a more balanced amino acid profile¹⁸. Consequently, careful menu planning and dietary diversity may help ensure adequate protein quality in vegan diets.

Calcium values in the evaluated vegan menus remained below the reference range. Although non-vegetarian and vegetarian menus contained similar amounts of dairy products, vegan menus were dairy-free. In line with these findings, a systematic review and meta-analysis reported that vegans have significantly lower calcium intakes than vegetarians and omnivores, whereas calcium intake was similar between vegetarians and non-vegetarians¹⁹. Lacto-vegetarians are generally not considered at risk of calcium deficiency, whereas vegans tend to have lower calcium intake²⁰. Although calcium is found in dairy products and certain plant foods, such as green leafy vegetables, its bioavailability in plant-based diets may be limited by phytate, oxalate, and fibre²¹. Nevertheless, adequate calcium intake can be achieved through careful food selection, calcium-fortified foods, and, when necessary, appropriate supplementation¹⁹. According to the Institute of Medicine, the recommended calcium intake is 1,000 mg/day for adults aged 19–50 years and 1,200 mg/day for older adults, highlighting the importance of careful calcium planning in vegan diets²².

In the study by Selinger et al.²³, vegans were found to have lower vitamin B12 levels compared to non-vegans. In addition, vegans who did not use vitamin B12 supplements had lower levels than those who used them regularly. In the present study, vitamin B12 values in both vegetarian and vegan menus remained below the reference range. However, this finding is not unexpected because vitamin B12 is naturally absent from most plant foods and adequate intake in vegan diets generally depends on fortified foods or supplementation²⁵. Vitamin B12 is primarily found in animal-derived foods and plays an essential role in blood formation and nervous system function. Deficiency may lead to megaloblastic anaemia and neurological complications²⁴. Therefore, adequate vitamin B12 intake can be achieved in well-planned vegan or plant-based diets through the use of fortified foods and appropriate supplementation²⁵.

Iron values in the evaluated menus were generally within the reference range, representing another favourable characteristic of the evaluated plant-based menus. Although iron is generally present at adequate levels in vegetarian meals, there are important differences between heme iron and non-heme iron. Heme iron is found only in animal foods and is more readily absorbed than non-heme iron of plant origin¹⁶. Non-heme iron is found in plant foods such as whole grain cereals, breads, dried beans, legumes, dark green leafy vegetables, dried fruits and nuts²⁶. However, due to the absence of heme iron in plant-based diets, iron bioavailability may be lower. Consumption of foods rich in ascorbic acid may enhance the absorption of non-heme iron and help reduce this limitation¹⁶. In this context, a varied and well-planned vegetarian diet may support adequate iron intake and help minimise the risk of iron deficiency¹⁵.

Conclusion

This study provides a theoretical evaluation of the nutritional composition of planned lunch menus in university cafeterias. Within the reference framework used, vegetarian menus generally met the recommended range for most nutrients, whereas vitamin B12 in vegetarian menus and both vitamin B12 and calcium in vegan menus remained below the reference range. Overall, the findings suggest that appropriately planned vegetarian and vegan lunch menus can provide nutritionally adequate meal options, although careful menu planning remains essential to ensure adequate vitamin B12 and calcium intake. Importantly, these findings are based on the analysis of a single meal (lunch) and do not represent total daily dietary intake. In addition, the potential use of dietary supplements, which is common among individuals following vegan diets, was not considered in this evaluation and may influence overall nutrient adequacy. These findings reflect menu planning rather than actual food consumption and should be interpreted within this context. Improving menu diversity and incorporating nutrient-rich or fortified options, particularly for vitamin B12 and calcium, may help enhance the nutritional adequacy of vegan and vegetarian menus. Future studies including longer evaluation periods and actual food consumption data are needed to better assess overall dietary adequacy.

REFERENCES

1. Kiely ME. Risks and benefits of vegan and vegetarian diets in children. *Proc Nutr Soc.* 2021;80(2):159–164. doi: 10.1017/S002966512100001X.
2. Craig WJ, Mangels AR, Fresán U, et al. The safe and effective use of plant-based diets with guidelines for health professionals. *Nutrients.* 2021;13(11):4144. doi: 10.3390/nu13114144.
3. Bakaloudi DR, Halloran A, Rippin HL, et al. Intake and adequacy of the vegan diet: A systematic review of the evidence. *Clin Nutr.* 2021;40(5):3503–3521. doi: 10.1016/j.clnu.2020.11.035.
4. Alexy U. Diet and growth of vegetarian and vegan children. *BMJ Nutr Prev Health.* 2023;6. doi: 10.1136/bmjnp-2023-000697.
5. Cramer H, Kessler CS, Sundberg T, et al. Characteristics of Americans choosing vegetarian and vegan diets for health reasons. *J Nutr Educ Behav.* 2017;49(7):561-567.
6. Fresán U, Sabaté J. Vegetarian diets: Planetary health and its alignment with human health. *Adv Nutr.* 2019;10(4):388. doi: 10.1093/advances/nmz019.
7. Al-Mohaithef M. Prevalence of vegan/vegetarian diet and eating behavior among Saudi adults and its correlation with body mass index: A cross-sectional study. *Front Nutr.* 2022;9:966629. doi: 10.3389/fnut.2022.966629.
8. González-García S, Esteve-Llorens X, Moreira MT, Feijoo G. Carbon footprint and nutritional quality of different human dietary choices. *Sci Total Environ.* 2018;644:77–94. doi: 10.1016/j.scitotenv.2018.06.339.
9. Ruini LF, Ciati R, Pratesi CA, Marino M, Principato L, Vannuzzi E. Working toward healthy and sustainable diets: The "double pyramid model" developed by the Barilla Center for Food and Nutrition to raise awareness about the environmental and nutritional impact of foods. *Front Nutr.* 2015;2:9. doi: 10.3389/fnut.2015.00009.
10. Gökçen M, Aksoy YC, Ateş Ozcan B. Overview of vegan nutrition in regards to health. *J Health Life Sci.* 2019;1(2):50-54.
11. Güneş Bayır A, Kıyak B. İklim destekli beslenmede bitki bazlı diyetler ve sağlık üzerine etkileri. *Akad Et Süt Kurumu Dergisi.* 2022;(4):35-54.
12. T.C. Sağlık Bakanlığı. *Türkiye Beslenme Rehberi 2022 (TUBER)*. Ankara: Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü; 2022.

13. T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü. *Toplu beslenme sistemleri (toplu tüketim yerleri) için ulusal menü planlama ve uygulama rehberi*. Ankara: Sağlık Bakanlığı; 2020.
14. Baycan B, Ertaş Öztürk Y. More protein, less vitamin D and omega-3: An observational study of infant and toddler nutrition and maternal feeding attitudes from Türkiye. *Food Sci Nutr*. 2025;13(8):e70759.
15. Anindya RN, Ervina E. Macronutrient and micronutrient intake in vegetarian and non-vegetarian groups of young adults. In: *IOP Conference Series: Earth and Environmental Science*. 2024;1302(1):012081.
16. Sakkas H, Bozidis P, Touzios C, et al. Nutritional status and the influence of the vegan diet on the gut microbiota and human health. *Medicina (Kaunas)*. 2020;56(2):88. doi: 10.3390/medicina56020088.
17. Allès B, Baudry J, Méjean C, et al. Comparison of sociodemographic and nutritional characteristics between self-reported vegetarians, vegans, and meat-eaters from the NutriNet-Santé study. *Nutrients*. 2017;9(9):1023. doi: 10.3390/nu9091023.
18. Aaslyng MD, Dam AB, Petersen IL, Christoffersen T. Protein content and amino acid composition in the diet of Danish vegans: A cross-sectional study. *BMC Nutr*. 2023;9(1):131. doi: 10.1186/s40795-023-00793-y.
19. Bickelmann FV, Leitzmann MF, Keller M, Baurecht H, Jochem C. Calcium intake in vegan and vegetarian diets: A systematic review and meta-analysis. *Crit Rev Food Sci Nutr*. 2022;63(31):10659–10677. doi: 10.1080/10408398.2022.2084027.
20. Falchetti A, Cavati G, Valenti R, et al. The effects of vegetarian diets on bone health: A literature review. *Front Endocrinol (Lausanne)*. 2022;13:899375. doi: 10.3389/fendo.2022.899375.
21. Özcan T, Baysal S. Vejetaryen beslenme ve sağlık üzerine etkileri. *Uludağ Üniv Ziraat Fak Dergisi*. 2016;30(2):101-116.
22. Institute of Medicine. *Dietary Reference Intakes for Calcium and Vitamin D*. National Academies Press; 2011.
23. Selinger E, Kühn T, Procházková M, Anděl M, Gojda J. Vitamin B12 deficiency is prevalent among Czech vegans who do not use vitamin B12 supplements. *Nutrients*. 2019;11(12):3019. doi: 10.3390/nu11123019.
24. Alqurashi RM, Aladwani A, Alosaimi TH, Yousef DB, Alkhalidi MH, Amer MG. Awareness of the effect of vitamin B12 deficiency on the nervous system among

the general population in Taif, Saudi Arabia. *Cureus*. 2023;15(11). doi: 10.7759/cureus.49343.

- 25.** Niklewicz A, Smith AD, Smith A, et al. The importance of vitamin B12 for individuals choosing plant-based diets. *Eur J Nutr*. 2023;62(3):1551–1559. doi: 10.1007/s00394-022-03025-4.
- 26.** Saunders AV, Craig WJ, Baines SK, Posen JS. Iron and vegetarian diets. *Med J Aust*. 2013;199:4-16. doi: 10.5694/mja11.11494.

Evaluation of the Relationships between International Students' Levels of Adaptation to Turkish Cuisine and Anthropometric Measurements: An Analytical Cross-Sectional Research*

Şule ARSLAN**, Can ERGÜN***, Elif Gülfem KİRAZ****

Abstract

Aim: This study aimed to evaluate the association between international university students' adaptation to Turkish cuisine and their anthropometric measurements. The notion of "dietary acculturation" is utilised as the chief analytical framework to elucidate nutrition-related alterations occurring throughout the migration process.

Method: A sample of 183 international students enrolled in higher education institutions in Türkiye was used to conduct the research. The participants' dietary habits, their level of familiarity with Turkish cuisine, and their physical measurements were all carefully evaluated. Additionally, we examined the influence of factors such as length of residence, cultural affinity, and geographical similarity on these variables.

Results: The findings indicated that 41.0% of the participants reported weight gain following their arrival in Türkiye. Adaptation to Turkish cuisine was positively associated with a longer duration of residence in Türkiye. On the other hand, cultural and geographical closeness did not show a statistically significant effect on the dietary acculturation path. BMI distribution also differed significantly according to duration of residence ($p=0.037$): the combined proportion of overweight and obese participants remained between 27% and 40% during the first seven years of residence but fell to 14.3% among those who had lived in Türkiye for seven years or more, 85.7% of whom were of normal weight. The weight gain reported after arrival therefore suggests a possible increase in metabolic and nutrition-related health risks in the earlier years of residence, whereas the BMI distribution appears to shift towards the normal range among longer-term residents.

Conclusion: The findings suggest that dietary acculturation among international students is associated with increased adaptation to Turkish cuisine and may be accompanied by weight gain, particularly during the earlier years of residence, while the BMI distribution shifts towards the normal range among students with longer periods of residence. To reduce the risk of health problems, it is a good idea to create specific plans that encourage healthy eating and to include nutrition education in wider cultural adaptation

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 22.12.2025 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1831855>

* This study has been derived from the master's thesis titled "Evaluation of the relationships between international students' levels of adaptation to Turkish cuisine and anthropometric measurements", which was accepted in 2022 at Bahçeşehir University Institute of Graduated School Department of Nutrition and Dietetics and prepared by Elif Gülfem KİRAZ under the consultancy of Assoc. Prof. Can ERGÜN.

** Asst. Prof., Istanbul Aydın University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: sulearslan2@aydin.edu.tr [ORCID https://orcid.org/0000-0001-5605-0718](https://orcid.org/0000-0001-5605-0718)

*** Assoc. Prof., Istanbul Aydın University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: canergun@aydin.edu.tr [ORCID https://orcid.org/0000-0001-5139-4407](https://orcid.org/0000-0001-5139-4407)

**** MSc, Bahçeşehir University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: elifgulfem95@gmail.com [ORCID https://orcid.org/0000-0003-3024-6100](https://orcid.org/0000-0003-3024-6100)

ETHICAL STATEMENT: The protocol was approved by the Non-Interventional Research Ethics Committee of the Bahçeşehir University, Türkiye (Number: E.1940, Date: 14/05/2020).

programmes.

Keywords: International student, dietary acculturation, Turkish cuisine.

Uluslararası Öğrencilerin Türk Mutfağına Uyum Düzeyleri ve Antropometrik Ölçümleri Arasındaki İlişkilerin Değerlendirilmesi: Analitik Kesitsel Çalışma

Öz

Amaç: Bu çalışma, Türkiye’de yükseköğrenim gören uluslararası öğrencilerin Türk mutfağına uyum düzeyleri ile antropometrik göstergeleri arasındaki ilişkiyi niceliksel olarak değerlendirmeyi amaçlamaktadır. Araştırmada “diyet kültürleşmesi” kavramı göç sürecindeki beslenme adaptasyonunu açıklayan temel çerçeve olarak kullanılmıştır.

Yöntem: Araştırmanın örneklemini Türkiye’de öğrenim gören 183 uluslararası öğrenci oluşturmuştur. Diyet kültürleşmesi düzeyi, Türk mutfağına uyum ve öğrencilerin antropometrik ölçümleri değerlendirilmiş; göç süresi, kültürel ve coğrafi yakınlık gibi değişkenlerin etkileri analiz edilmiştir.

Bulgular: Katılımcıların %41,0’ı Türkiye’ye geldikten sonra vücut ağırlığında artış yaşamıştır. Ülkede kalma süresi uzadıkça Türk mutfağına uyum düzeyinin arttığı belirlenmiştir. Bununla birlikte, kültürel veya coğrafi yakınlığın diyet kültürleşmesi üzerinde anlamlı bir etkisi olmadığı saptanmıştır. Vücut kitle indeksi (VKİ) dağılımı da kalış süresine göre anlamlı farklılık göstermiştir ($p=0,037$): hafif kilolu ve obez katılımcıların toplam oranı ilk yedi yıl boyunca %27–40 aralığında seyrederken, Türkiye’de yedi yıl ve üzerinde yaşayanlarda %14,3’e düşmüş, bu grubun %85,7’si normal kiloda bulunmuştur. Bu nedenle, Türkiye’ye geldikten sonra bildirilen ağırlık artışı ikamet süresinin ilk yıllarında metabolik ve beslenme temelli sağlık risklerini artırabilecek nitelikte görünmekte; uzun süreli ikamette ise VKİ dağılımının normal aralığa doğru kaydığı izlenmektedir.

Sonuç: Uluslararası öğrencilerde Türk mutfağına uyum süreci, zamanla artan bir diyet kültürleşmesi ve özellikle ilk yıllarda buna eşlik eden ağırlık artışı ile ilişkilidir; buna karşın uzun süreli ikamette VKİ dağılımı normal aralığa doğru kaymaktadır. Bu nedenle, sağlıklı beslenme davranışlarını destekleyen müdahalelerin geliştirilmesi ve kültürel uyum süreçlerine entegre edilebilecek beslenme eğitimi programlarının uygulanması önerilmektedir.

Anahtar Sözcükler: Uluslararası öğrenci, diyet kültürleşmesi, Türk mutfağı.

Introduction

Notwithstanding the historical predilection of migration research to emphasise long-term or permanent population movements, a considerable proportion of contemporary mobility is characterised by its ephemeral nature. More than three million students have taken part in international education programmes worldwide in the last decade, with many choosing to participate in short- or medium-term academic mobility programmes. Given the distinct challenges faced by international students and the specific support needed in higher education settings, nutrition-related transitions during temporary migration have become a key focus of academic research. The global higher education arena is seeing an increasing role for international student mobility, which is contributing to academic advancement as well as broader social, cultural, economic, and political spheres¹. Notable expansion in higher education has been undergone by Turkey in recent years, accompanied by a substantial rise in the number of international

students enrolled in its universities. This rapid increase has, in turn, led to academic interest in the living conditions, adjustment processes, and overall well-being of this population within the Turkish context². As international students become familiar with and gradually adopt the cultural norms and daily practices of the host society, their dietary behaviours may also change. Research undertaken with international students has indicated that the acclimatisation process may be accompanied by experiences of solitude, cultural dissonance, social isolation, and other psychological stressors³. The notion of dietary acculturation characterises the slow assimilation of the host society's eating habits, choices, and consumption standards by ethnic minorities. Prior evidence indicates an association of unfavorable health outcomes among migrants with higher degrees of dietary acculturation and increased alignment with the dominant dietary patterns of the host country, including elevated Body Mass Index (BMI), overweight, and obesity⁴.

Dietary Acculturation

The notion of acculturation is comprehensively employed to delineate the process through which racial or ethnic minority groups assimilate and obtain the social, cultural, and behavioural norms of a dominant or host society. Dietary acculturation refers to the process through which individuals gradually adopt the dietary practices of the host society while maintaining elements of their traditional eating patterns. The recognition of dietary acculturation as a multidimensional and dynamic process that unfolds through the interplay of individual characteristics, cultural influences, and environmental conditions. Importantly, dietary acculturation is neither linear nor uniform. Individuals rarely abandon their traditional dietary habits entirely; rather, they tend to combine elements of both their original and host-country food cultures. Acculturation involves the adoption of selected practices of the host culture while retaining aspects of one's original cultural identity. In the context of dietary acculturation, individuals often maintain certain traditional eating habits while incorporating new foods and dietary practices encountered in the host society. For example, among many Asian immigrants, rice frequently remains a staple food, while foods commonly consumed in the host country, such as breakfast cereals, sandwiches, and dairy products, may gradually be incorporated into the diet⁵. The way people from different cultures adapt their diets can have positive and negative effects on their eating habits. It was demonstrated by a study that was conducted among South Asian immigrants in Canada that improvements in their dietary habits were experienced by many participants after migration. There were modest increases in fruit and vegetable intake. There were also reductions in the consumption of high-fat and fried foods. There was a shift toward healthier cooking methods. These changes included a shift from frying to grilling and were accompanied by reductions in Body Mass Index (BMI). However, no significant association was found between increases in nutritional awareness and healthier food choices and the duration of residence in the host country⁶. A study of Chinese students in the United States looked at how culture and the environment affect dietary habits and BMI. The findings revealed a significant dietary acculturation process, with post-migration weight gain reported by 69% of male students and 85% of female students⁷. The experience of migration is always

accompanied by acculturation, which can have positive or negative effects on the health of migrants. Modifications in dietary patterns and food-related behaviours may result in deleterious outcomes, including an elevated risk of nutrition-related chronic diseases. Supporting this, a study investigating dietary acculturation among foreign-born children living in the US found that the longer they had lived there, the higher their BMI and blood pressure⁸.

Migration and Emotional Eating Behavior

The complex interactions among physiological, psychological, social, and cultural factors in individuals are reflected in eating behaviours⁹. In this context, individuals' eating behaviours are typically categorised into three domains: emotional eating, which occurs in response to affective states; restrained eating, which is characterised by the intentional limitation of food intake to reduce or maintain body weight; and external eating, which is triggered by external cues such as the aroma, appearance, or texture of foods. Migration may be associated with various psychological challenges, including stress, anxiety, and difficulties related to the adaptation process. Substantial changes in the living environment can also influence eating behaviours and food choices. Research has demonstrated a link between acculturative stress and heightened anxiety levels, which in turn can intensify the adverse effects of anxiety on eating habits. A study examining the relationship between acculturative stress, anxiety, and eating behaviours among Colombian migrants living in Chile found that anxiety was directly associated with acculturative stress and that elevated anxiety levels significantly predicted emotional eating behaviours¹⁰.

Material and Methods

This cross-sectional study was conducted among international students enrolled at Bahçeşehir University. The study population consisted of 4.648 international students registered at the university during the 2020 academic year.

Participants were recruited on a voluntary basis. International students who had been living continuously in Türkiye for at least six months and had sufficient English proficiency to complete the questionnaire were included in the study. Individuals with a diagnosed chronic disease, those regularly using medications that could affect taste perception, students with insufficient English proficiency, and those who had stayed in Türkiye for less than six months or intermittently were excluded.

The minimum sample size was calculated using G*Power version 3.1 software based on a one-way analysis of variance (ANOVA) model. Assuming a medium effect size ($f=0.25$), a significance level of 0.05, and a statistical power of 80% ($1-\beta = 0.80$), the minimum required sample size was estimated to be 180 participants. Considering possible incomplete responses, a total of 183 international students were ultimately included in the study.

Data were collected using a structured questionnaire consisting of demographic characteristics, migration-related information, and the Turkish Cuisine Adaptation Scale, originally developed as the Culinary Acculturation Assessment Inventory (CAAI). The questionnaire was developed based on the relevant literature.

The CAAI was developed to assess culinary acculturation among immigrants and international individuals living in Türkiye. Unlike conventional dietary acculturation instruments that primarily focus on food intake, the CAAI evaluates broader aspects of culinary adaptation, including food preferences, meal patterns, cooking practices, food preparation behaviors, commensality, and culturally specific culinary exposures.

The theoretical framework of the inventory was based on previously established dietary acculturation and culinary acculturation models described in the literature. The scale development process included an extensive literature review, pilot testing, expert interviews, and focus group discussions conducted with immigrants from diverse cultural backgrounds residing in Türkiye. The validity and reliability study of the scale was conducted by Zeynep Begüm Kalyoncu at Hacettepe University in 2018¹¹. As the study population consisted of international students studying in Türkiye, all questionnaires and scale forms were administered in English.

Anthropometric measurements were obtained by the researcher using standardized procedures. Body weight and height were measured, and body mass index (BMI) was calculated as follows: $BMI = \text{weight (kg)} / \text{height (m)}^2$. BMI values were classified according to the criteria of the World Health Organization.

The questionnaire, including demographic information and the Turkish Cuisine Adaptation Scale, was administered face-to-face in a confidential setting. Anthropometric measurements were obtained during the interview process by the researcher.

Ethical Statement

The protocol was approved by the Non-Interventional Research Ethics Committee of the Bahçeşehir University, Türkiye (Number: E.1940, Date: 14/05/2020).

Statistical Analyses

Participants' countries of origin were categorized into geographical regions to facilitate the evaluation of cultural interaction with Turkish cuisine. These categories included the Middle East, Asia, Europe, the Balkans, Eurasia, and Africa. Statistical analyses were performed using IBM SPSS Statistics. Data distribution was assessed prior to analysis. As the data demonstrated normal distribution, one-way analysis of variance (ANOVA) was used for comparisons between groups, followed by Bonferroni post-hoc analysis where appropriate. The association between duration of stay in Türkiye and BMI categories was evaluated using the chi-square test. Independent-samples t-tests were

used to compare Turkish cuisine adaptation scores according to sex and cohabitation with Turkish individuals. Statistical significance was set at $p < 0.05$.

Results

Of the 183 participants, 37.2% were female and 62.8% were male. Participants originated primarily from the Middle East (58.1%), followed by Africa (14.1%), the Americas (7.1%), Europe (5.4%), Asia (2.7%), the Balkans (2.7%), and Eurasia (9.9%). When the participants' body weights were examined, the mean was 70.13 kg, the median was 70, the standard deviation was 13.72, the minimum value was 46, and the maximum value was 110. When the participants' heights were examined, the mean was 172.44 cm, the median was 173, the standard deviation was 11.66, the minimum value was 152, and the maximum value was 197. Examination of body mass index (BMI) categories revealed that 8.7% were underweight, 62.3% were of normal weight, 20.8% were overweight, and 8.2% were obese. Among the participants, 41.0% reported weight gain after arriving in Türkiye, whereas 21.9% reported weight loss. Additionally, 4.4% stated that they did not remember their previous body weight, while 32.8% reported no change in weight. The mean weight gain was 7.55 kg, whereas the mean weight loss was 6.33 kg.

While 32.2% of participants have a Turkish family member in their nuclear family, 67.8% do not have a Turkish relative. 50.8% of participants have never lived with a Turkish person before, while 49.2% have. When looking at the length of time participants have lived in Turkey, 15.3% have lived there for less than 1 year, 49.7% for 1–4 years, 23.5% for 4–7 years, and 11.5% for 7 years or more.

In the assessment of the Diet subscale, no significant differences were found across participants' geographic categories for any of the items ($p > 0.05$); however, in the assessment of the Cooking Behaviors subscale, significant differences were found regarding the frequency of using different types of oil and the frequency of using onions, tomatoes, and/or tomato paste as a base when cooking ($p < 0.05$). When examining post-hoc statistics to determine the source of the difference, it was found that participants from Balkan countries consumed a greater variety of oils compared to participants from other countries. The use of the classic base method for cooking was more prevalent among participants from Balkan and Asian countries.

Tables 1 and 2 show the results of the research on the differences and links between the countries the participants are from and how they have adjusted to Turkish food. As demonstrated in Table 1, no substantial variations were detected across geographical categories. As shown in Table 2, there was no clear link between the geographical origins of the participants and their overall adaptation scores ($p > 0.05$).

Table 1. Analysis of differences in total scores of adaptation to Turkish Cuisine Across Geographical Categories.

Geographical Categories	Middle East	Africa	North & South America	Asia	Europe	Balkan Countries	Eurasian Countries	P ^a
Diet Subscale	46.16±12.12	42.65±12.78	46.46±5.42	47.80±6.26	42.70±10.95	44.40±17.92	40.33±12.11	0.467
Culinary Behaviors Subscale	45.39±10.85	41.11±11.23	44.84±7.40	43.00±11.45	40.00±10.72	42.40±9.04	41.27±7.56	0.326
Turkish Cuisine Adaptation Score (Total)	91.55±20.90	83.76±21.11	91.30±11.51	90.80±11.45	82.70±18.64	86.80±25.81	81.61±17.27	0.795

Total Score ($\bar{x} \pm ss$), p^a = ANOVA test

Table 2. Results of correlation analysis between geographical category and total scores of adaptation to Turkish Cuisine.

Total Scores	Correlation Result	
Diet Subscale	r	-0.102
	p	0.074
Culinary Behaviors Subscale	r	-0.142
	p	0.055
Turkish Cuisine Adaptation Score (Total)	r	-0.151
	p	0.061

The results of the analysis of the Diet subscale, the Culinary Behaviours subscale and the total Turkish Cuisine Adaptation score revealed that participants who had been living in Türkiye for seven years or more exhibited higher mean values compared with the other groups (Table 3). Duration of residence was positively and significantly, although weakly, correlated with the Diet subscale score ($r=0.241$, $p=0.001$), the Culinary Behaviours subscale score ($r=0.175$, $p=0.018$) and the total Turkish Cuisine Adaptation score ($r=0.192$, $p=0.035$); the proportions of explained variance were 5.8%, 3.1% and 3.7%, respectively (Table 4). At the item level, significant differences by duration of residence were observed within the Diet subscale for the frequency of consuming different types of bread, meat-based stews, olive oil-based vegetable dishes and seasonal vegetables (Table 5). Post-hoc comparisons indicated that participants who had stayed for less than one year consumed different types of bread more frequently, those who had stayed for seven

years or more consumed meat-based stews more frequently, and those who had stayed for one to four years consumed olive oil-based vegetable dishes and seasonal vegetables more frequently. Within the Culinary Behaviours subscale, significant differences were found for the frequency of preparing a Turkish breakfast, the frequency of preparing traditional Turkish beverages, the frequency of preparing Turkish dishes and the frequency of eating three regular meals a day ($p=0.003$, $p=0.009$, $p=0.010$ and $p=0.001$, respectively, ANOVA); for each of these items post-hoc analysis showed that participants who had remained in Türkiye for seven years or more obtained the highest scores ($4>1$, $4>2$, $4>3$).

Table 3. Analysis of differences in total scores of adaptation to Turkish cuisine by duration of residence in Türkiye.

Duration of stay in Turkey	(1) <1 year	(2) 1-4 year	(3) 4-7 year	(4) 7 + year	p ^a	Post-hoc
Diet Subscale	44.00±13.86	47.87±11.64	43.16±12.03	49.95±8.80	0.000*	4>1,4>3, 2>3
Culinary Behaviors Subscale	44.61±9.99	42.70±10.64	42.74±9.49	50.52±8.93	0.013*	4>1,4>2, 4>3
Turkish Cuisine Adaptation Score (Total)	88.61±21.17	87.57±20.17	85.91±19.61	100.48±15.31	0.037*	4>1,4>2, 4>3

Total Score ($\bar{x}\pm sd$), * $p<0.05$ was considered statistically significant, p_a = ANOVA test, Post-Hoc = Bonferroni test

Table 4. Relationship between duration of stay in Türkiye and adaptation to Turkish cuisine scores.

Total Scores	Correlation Results	
Diet Subscale	r	0.241*
	p	0.001
Culinary Behaviors Subscale	r	0.175*
	p	0.018
Turkish Cuisine Adaptation Score (Total)	r	0.192*
	p	0.035

*A significant relationship at the 0.05 level, r=Pearson correlation coefficient

Pearson correlation analyses were also carried out between duration of residence in Türkiye and the individual scale items. Within the Diet subscale, a significant negative correlation was found between duration of residence and the frequency of consuming different types of bread ($r=-0.358$, $p=0.003$), indicating that bread consumption tended to decrease as duration of residence increased. This is consistent with Table 5, in which participants who had lived in Türkiye for less than one year reported the highest bread consumption ($1>2$, $1>3$, $1>4$). Significant positive correlations were observed for the frequency of consuming meat-based stews ($r=0.329$, $p=0.007$), olive oil-based vegetable dishes ($r=0.464$, $p=0.001$) and seasonal vegetables ($r=0.413$, $p=0.002$).

No significant correlations were found for the remaining Diet subscale items ($p>0.05$). Within the Culinary Behaviours subscale, duration of residence was significantly and positively correlated with the frequency of preparing a Turkish breakfast ($r=0.237$, $p=0.001$), the frequency of preparing Turkish dishes ($r=0.209$, $p=0.005$) and the frequency of eating three regular meals a day ($r=0.339$, $p=0.007$); the remaining items of this subscale were not significantly correlated with duration of residence ($p>0.05$).

At the subscale level, duration of residence in Türkiye was significantly and positively correlated with the Diet subscale ($r=0.241$, $p=0.001$), the Culinary Behaviours subscale ($r=0.175$, $p=0.018$) and the total Turkish Cuisine Adaptation score ($r=0.192$, $p=0.035$). All three coefficients indicate weak positive associations, corresponding to 5.8%, 3.1% and 3.7% of the explained variance, respectively (Table 4).

Table 5. Analysis of differences in Diet subscale items by duration of residence in Türkiye.

Duration of stay in Türkiye	(1) <1 year	(2) 1–4 years	(3) 4–7 years	(4) 7+ years	pa	Post-hoc
Frequency of consuming different types of bread	5.89±1.93	5.64±1.99	5.37±1.94	5.14±2.46	0.000*	1>2, 1>3, 1>4
Frequency of consuming different types of soup	4.07±1.92	5.03±1.88	5.00±1.85	4.52±2.16	0.102	–
Frequency of consuming meat-based stews	4.46±2.08	4.76±1.75	4.53±1.91	5.10±1.70	0.000*	4>1, 4>2, 4>3
Frequency of consuming olive oil-based vegetable dishes	4.32±2.18	4.69±2.03	4.35±1.86	4.48±2.02	0.000*	2>1, 2>3, 2>4
Frequency of consuming seasonal vegetables	4.43±2.22	5.45±1.99	5.09±1.74	4.76±2.34	0.000*	2>1, 2>3, 2>4
Frequency of consuming a Turkish breakfast	5.43±2.28	5.31±1.96	5.44±1.89	4.62±2.42	0.459	–

Frequency of consuming yoghurt, ayran, cacik or kefir with meals	4.61±2.44	4.91±2.09	5.26±1.98	5.05±2.38	0.651	–
Frequency of consuming Turkish-style brewed tea	5.57±2.69	5.77±2.25	5.00±2.59	5.38±2.54	0.395	–
Frequency of consuming Turkish coffee	4.68±2.55	4.67±2.55	4.05±2.73	3.81±2.60	0.369	–

Values are given as $\bar{x} \pm \text{sd}$. * $p < 0.05$ was considered statistically significant. pa = ANOVA test, Post-hoc = Bonferroni test

Lastly, a significant association was found between duration of residence in Türkiye and BMI category (Pearson chi-square, $p = 0.037$). Among participants who had lived in Türkiye for less than one year ($n = 28$), 71.4% were of normal weight and 28.6% were overweight or obese; the corresponding proportions were 62.6% and 27.5% in the one-to-four-year group ($n = 91$), 44.2% and 39.5% in the four-to-seven-year group ($n = 43$), and 85.7% and 14.3% in the group with seven or more years of residence ($n = 21$). The proportion of participants classified as overweight or obese therefore remained between 27% and 40% during the first seven years of residence, but fell to 14.3% among those with seven or more years of residence, 85.7% of whom were of normal weight.

Discussion

The primary aim of this study was to evaluate the level of adaptation to Turkish cuisine among international students pursuing higher education in Türkiye and to examine its association with nutritional status and anthropometric measurements. Adapting to the culinary practices of a host country while maintaining traditional dietary habits can be a challenging process for international students. Limited access to familiar foods, academic workload, time constraints related to meal preparation, financial difficulties, and cultural and environmental differences may all influence dietary behaviors during the adaptation period. These factors may contribute to changes in food preferences and eating patterns, which could potentially be associated with variations in body weight and anthropometric measurements¹².

Previous studies have suggested that changes in dietary habits following migration may be associated with alterations in BMI values and body weight. However, some evidence also indicates that international students may become more aware of weight changes over time and subsequently attempt to regulate their dietary intake. In a study conducted by Smith and Wu among Chinese students studying in the United States, participants who had resided in the host country for six months or longer experienced increases in BMI values in both males and females.⁷ Similar findings have been reported in other studies demonstrating that dietary changes associated with migration and acculturation may influence weight status¹³. A study conducted in South Korea also reported increases in body weight and BMI among international students following short-term migration¹⁴.

Consistent with the existing literature, the present study found that 41.0% of international students reported weight gain after arriving in Türkiye, whereas 21.9% reported weight loss. In contrast, 32.8% reported no change in body weight, and 4.4% were unable to recall their previous weight. Furthermore, a significant association was observed between duration of residence in Türkiye and BMI categories.

Our findings further demonstrated that BMI values tended to be higher among participants who had resided in Türkiye for one to four years, whereas lower BMI values were observed among those with longer residence durations. One possible explanation for this pattern may be the process of acculturation, defined as the adoption of beliefs and behaviors of another cultural group. Dietary acculturation is considered a multidimensional and dynamic process that may vary according to factors such as age, sex, socioeconomic status, duration of residence, and cultural proximity to the host country.

Supporting this interpretation, a study examining dietary intake among South Asian immigrants in the United States reported that individuals with longer residence duration consumed lower amounts of rice, starchy vegetables, sugars, sweets, and jams, whereas consumption of solid and liquid fats was positively associated with acculturation¹⁵. Similarly, another study investigating dietary acculturation among Indian international students in the United States found that students who had lived in the country for at least two years demonstrated higher dietary acculturation scores compared with those residing for less than one year¹⁶.

Although previous findings regarding the relationship between dietary acculturation and duration of residence have been inconsistent, the present study suggests that longer residence in Türkiye may be associated with greater adaptation to Turkish cuisine. Nevertheless, the findings should be interpreted cautiously due to the cross-sectional design of the study, which does not allow causal inferences to be established. Further longitudinal studies are needed to better clarify the long-term relationship between dietary acculturation, nutritional status, and anthropometric outcomes among international students.

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design precludes the establishment of causal relationships between adaptation to Turkish cuisine, dietary habits, and changes in body weight. Second, the data were collected using self-reported questionnaires, which may be subject to reporting bias and social desirability bias. In addition, information regarding body weight before arrival in Türkiye was based on participants' recall, introducing the possibility of recall bias. Third, the study was conducted at a single university, which may limit the generalizability of the findings to all international students in Türkiye. Finally, the diverse cultural and geographical backgrounds of the participants may have influenced dietary behaviors and adaptation processes in ways that were not fully captured in the present study. Despite these limitations, the study provides valuable insights into dietary adaptation, nutrition-related behaviors, and weight changes among international students living in Türkiye.

Conclusion

This study examined the adaptation of international university students to Turkish cuisine and its relationship with anthropometric characteristics. The findings indicate that international students gradually adapt to Turkish cuisine during their stay in Türkiye. While geographical proximity to Türkiye was not associated with adaptation scores, a longer duration of residence was positively related to adaptation to Turkish cuisine, suggesting that dietary acculturation increases over time.

A considerable proportion of participants reported weight gain after arriving in Türkiye, and a significant association was observed between duration of residence and BMI category. The proportion of participants classified as overweight or obese was highest during the first seven years of residence and markedly lower thereafter, suggesting that the weight changes accompanying dietary acculturation may be most pronounced in the earlier stages of adaptation. Because of the cross-sectional design, this pattern should be interpreted as a between-group difference rather than as a within-person change over time. These findings nevertheless highlight the potential influence of dietary acculturation and lifestyle changes on body weight among international students. As the number of international students continues to increase, greater attention should be given to supporting healthy dietary practices during the adaptation process.

Nutrition education programmes, culturally sensitive dietary counselling, and university-based health promotion initiatives may help international students maintain healthy eating habits while adapting to a new food environment. Further longitudinal studies involving students from different universities are needed to better understand the long-term effects of dietary acculturation on nutritional status and health outcomes.

REFERENCES

1. Kiroğlu K, Kesten A, Elma C. Türkiye’de öğrenim gören yabancı uyruklu lisans öğrencilerinin sosyo-kültürel ve ekonomik sorunları. *Mersin Univ J Fac Educ*. 2010;6(2):26-39.
2. Özer M. Türkiye’de uluslararası öğrenciler. *J High Educ Sci*. 2012;1:10-13.
3. Alakaam AA, Castellanos DC, Bodzio J, Harrison L. The factors that influence dietary habits among international students in the United States. *J Int Students*. 2015;5(2):104-120.
4. Serafica RC. Dietary acculturation in Asian Americans. *J Cult Divers*. 2014;21(4):145-151.
5. Satia JA. Dietary acculturation and the nutrition transition: An overview. *Appl Physiol Nutr Metab*. 2010;35(2):219-223.

6. Lesser IA, Gasevic D, Lear SA. The association between acculturation and dietary patterns of South Asian immigrants. *PLoS One*. 2014;9(2):e88495.
7. Wu B, Smith C. Acculturation and environmental factors influencing dietary behaviors and body mass index of Chinese students in the United States. *Appetite*. 2016;103:324-335.
8. Smith C, Franzen-Castle L. Dietary acculturation and body composition predict American Hmong children's blood pressure. *Am J Hum Biol*. 2012;24(5):666-674.
9. Campos MB, Menezes IHCF, Peixoto MDRG, Schincaglia RM. Intuitive eating in general aspects of eating behaviors in individuals with obesity: Randomized clinical trial. *Clin Nutr ESPEN*. 2022;50:24-32.
10. Hun N, Urzúa A, López-Espinoza A. Anxiety and eating behaviors: Mediating effect of ethnic identity and acculturation stress. *Appetite*. 2021;157:105006.
11. Kalyoncu ZB. Development of a New Scale to Measure Culinary Acculturation of Immigrants Living in Turkey: Validity and Reliability Assessment [master's thesis]. Ankara, Türkiye: Hacettepe University; 2018.
12. Mustafa E. The challenges of making food choice in a new country. *J Tourism Hosp Environ Manage*. 2019;4(14):51-61.
13. O'Sullivan N, Amirabdollahian F. Loyal tongue, liberal mind: international students' experiences on dietary acculturation in England. *J Int Students*. 2016;6(1):107-127.
14. Lee J, Gao RR, Kim JH. Acculturation and changes in dietary behavior and anthropometric measures among Chinese international students in South Korea. *Nutr Res Pract*. 2015;9(3):304-312.
15. Talegawkar SA, Kandula NR, Gadgil MD, Desai D, Kanaya AM. Dietary intakes among South Asian adults differ by length of residence in the USA. *Public Health Nutr*. 2016;19(2):348-355.
16. Ashy L, Shows AR, Chen J, Ruiz CS. Dietary acculturation of Asian Indian international students. *J Acad Nutr Diet*. 2015;115(9 Suppl):A75.

Effectiveness of Aerobic Exercise–Based Interventions in Children Exposed to Sexual Abuse*

Tuğçe BİLGİÇ**, Ali KARAAĞAÇ***, Caner MUTLU****, Ebru KAYA MUTLU*****

Abstract

Aim: Child sexual abuse exerts severe psychological and physiological effects on victims, frequently resulting in enduring and complex mental health difficulties throughout the lifespan. For this purpose, we examined the impact of physiotherapy-based aerobic exercise interventions on selected indicators of post-traumatic stress, physical activity levels and flexibility in children who have experienced sexual abuse.

Method: The study was designed with three groups, comprising a total of 34 participants. The groups included a control group, a home-exercise group, and a physiotherapist-guided exercise group, each receiving a 12-week intervention. Post-traumatic stress symptoms (Adolescent Dissociative Experiences Scale, A-DES), physical activity level (Physical Activity Questionnaire for Older Children, PAQ-C) and flexibility (Trunk Lateral Flexion Test) were assessed both before and after the intervention period.

Results: Statistically significant improvements were observed in the Trunk Lateral Flexion Test in all groups ($p < 0.05$). However, no statistically significant intra- or intergroup differences were found for dissociative experiences or physical activity levels ($p > 0.05$).

Conclusion: While no significant effects were observed on dissociative symptoms or physical activity levels, the findings may suggest that aerobic exercise has the potential to be integrated as a supportive component of multidisciplinary treatment approaches, particularly in future studies involving larger and more heterogeneous samples.

Keywords: Sexual abuse, children, aerobic exercise, post-traumatic stress.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 22.01.2026 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1869634>

* This study was derived from Tuğçe BİLGİÇ's Master's Thesis titled "The effects of aerobic exercises on psychiatric symptoms and physical fitness in posttraumatic period in children exposed to sexual abuse", which was accepted in 2019 at Istanbul University-Cerrahpaşa, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation under the consultancy of Prof. Dr. Ebru KAYA MUTLU.

** Asst. Prof., Avrasya University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Trabzon, Türkiye. E-mail: tugce.bilgic@avrasya.edu.tr [ORCID https://orcid.org/0000-0001-9685-7065](https://orcid.org/0000-0001-9685-7065)

*** Asst. Prof., Istanbul Gelisim University, Vocational School of Health Services, Istanbul, Türkiye.

E-mail: akaraagac@gelisim.edu.tr [ORCID https://orcid.org/0000-0002-4327-7347](https://orcid.org/0000-0002-4327-7347)

**** Prof. Dr., Uludağ University, Faculty of Medicine, Department of Child and Adolescent Psychiatry, Bursa, Türkiye.

E-mail: ccanermutlu@gmail.com [ORCID https://orcid.org/0000-0001-6507-8042](https://orcid.org/0000-0001-6507-8042)

***** Prof. Dr., Bandırma Onyedi Eylül University, Faculty of Health Sciences, Physiotherapy and Rehabilitation Department, Balıkesir, Türkiye. E-mail: fztebrukaya@hotmail.com [ORCID https://orcid.org/0000-0002-8595-5513](https://orcid.org/0000-0002-8595-5513)

ETHICAL STATEMENTS: Ethical approval was obtained from the Clinical Research Ethics Committee of Istanbul Bakırköy Prof. Dr. Mazhar Osman Mental Health and Neurological Diseases Training and Research Hospital with the approval number of 2018/234, and written informed consent was obtained from all participating children before enrollment.

Cinsel İstismara Maruz Kalan Çocuklarda Aerobik Egzersize Dayalı Müdahalelerin Etkinliği

Öz

Amaç: Çocuk cinsel istismarı, ciddi psikolojik ve fizyolojik sonuçlara yol açabilen ve sıklıkla yaşam boyu süren karmaşık ruh sağlığı sorunlarıyla ilişkili bir travmadır. Bu çalışmanın amacı, cinsel istismara maruz kalmış çocuklarda fizyoterapi temelli aerobik egzersiz müdahalelerinin travma sonrası stres belirtileri, fiziksel aktivite düzeyi ve esneklik üzerindeki etkilerini incelemektir.

Yöntem: Çalışma, toplam 34 katılımcı ile 12 haftalık bir müdahale süreci boyunca izlenen kontrol grubu, ev egzersiz programı grubu ve fizyoterapist rehberliğinde aerobik egzersiz uygulanan gruptan oluşmaktaydı. Travma sonrası stres belirtileri (Ergen Dissosiyatif Yaşantılar Ölçeği, A-DES), fiziksel aktivite düzeyi (Çocuklar İçin Fiziksel Aktivite Anketi, PAQ-C) ve esneklik (Gövde lateral Fleksiyon Testi) müdahale öncesinde ve sonrasında değerlendirildi.

Bulgular: Tüm gruplarda Gövde Lateral Fleksiyon Testi sonuçlarında istatistiksel olarak anlamlı iyileşmeler saptandı ($p < 0,05$). Dissosiyatif yaşantılar ve fiziksel aktivite düzeyleri açısından grup içi ya da gruplar arası istatistiksel olarak anlamlı bir fark bulunmadı ($p > 0,05$).

Sonuç: Bulgular, dissosiyatif belirtiler ve fiziksel aktivite düzeyleri üzerinde anlamlı bir etki göstermemekle birlikte, aerobik egzersizin daha geniş popülasyonlarda yapılacak çalışmalar kapsamında multidisipliner tedavi yaklaşımlarında destekleyici bir bileşen olarak değerlendirilebileceğini düşündürmektedir.

Anahtar Sözcükler: Cinsel istismar, çocuklar, aerobik egzersiz, travma-sonrası stres.

Introduction

Child sexual abuse (CSA) is a common and significant issue that affects children worldwide, leading to deeply and often long-lasting psychological, physical, and social consequences. A study indicated that the overall CSA was %12.7 in self-report studies and %0.4 in informant-based research, with females exhibiting higher rates than males¹. Previous research has consistently shown that exposure to sexual abuse during childhood is associated with numerous adverse psychosocial and health related consequences, encompassing emotional and behavioral challenges, self-injurious behaviors, various psychiatric conditions, and long-term obesity-like physical health problems²⁻⁴.

Eye Movement Desensitization and Reprocessing and Trauma Focused Cognitive Behavioral Therapy are among the most consistently supported therapeutic approaches for both children and adults, demonstrating effectiveness in reducing symptoms of Post-traumatic Stress Disorder (PTSD), depression, and anxiety⁵. Expressive arts therapies (including art, music, and dance) as well as massage therapy also appear promising, particularly for individuals who have difficulty expressing themselves verbally; however, more rigorous research is still needed to substantiate their effectiveness^{6,7}. In another study, after the classical massage practising to a group who had experienced sexual abuse, analyses of saliva and urine samples indicated a statistically significant elevation in activating neurotransmitter levels. —an average increase of 28% in serotonin and 31% in dopamine—alongside a marked reduction in cortisol levels⁸. In another study where the effects of body awareness therapy on stress disorders following sexual abuse kinds of

traumas were assessed, participants showed notable decrease in the severity of physical symptoms, as well as a tendency toward dissociative symptoms reduction compared to the control group⁹. Despite varying treatment approaches among individuals, none of the interventions has shown clear superiority over others especially for depression and chronic pain. This finding is expected based on the heterogeneous nature of sexual abuse cases, which vary according to factors such as the child's age, the type, severity, and duration of the abuse, the relationship between the child and the perpetrator, and the level of family support. Therefore, there is a clear need for the development of child-centered therapy approaches especially designed for sexual abuse victims¹⁰. Physical activity not only helps to reduce the physical problems associated with a sedentary lifestyle but also improves occupational productivity and cognitive functions. These benefits mostly occur through the effects on the central nervous system, particularly via hormones such as dopamine and serotonin that regulate emotional processes¹¹. For this reason, performing aerobic exercises—defined as prolonged, submaximal-intensity activities—may be challenging for individuals experiencing depressive symptoms. Therefore, aerobic exercise has been increasingly used as an additional tool to psychotherapy in treatment programs¹². For this purpose, Shors and colleagues (2018) compared mental and physical (MAP™) training, which combines specific mental exercises with meditation and aerobic exercises, to groups receiving only meditation combined with aerobic exercise in individuals who had experienced sexual abuse. Their results showed that exercise or meditation alone did not significantly reduce trauma-related cognitions and ruminations. However, better outcomes were observed when both components were combined within the MAP™ training¹³.

In the light of these findings, we hypothesized that the antidepressant effects of physiotherapy-based aerobic exercises could provide significant improvements by decreasing persistent post-traumatic symptoms and by increasing certain physical fitness parameters. The purpose of our study is to examine the effects of physiotherapy-based aerobic exercise on post-traumatic stress symptoms, physical activity levels and flexibility in children who experienced sexual abuse.

Material and Methods

Participants

This randomized controlled study was conducted with children at the Child Monitoring Center and the Adolescent Psychiatry Clinic in Istanbul Bakırköy Prof. Dr. Mazhar Osman Training Research Hospital between October 2018 to August 2019.

Inclusion criteria required participants to be girls between 8 and 17 years of age who had experienced sexual abuse and who voluntarily agreed—along with their families—to participate after the study aims and assessment procedures had been fully explained. Since these participants were children from the Child Monitoring Center involved in ongoing forensic/legal processes, all of them were already receiving routine psychiatric evaluation and treatment in accordance with institutional procedures and legal regulations. This information has been clarified in the revised manuscript to provide a

better understanding of the participants' clinical background and concomitant treatments. Exclusion criteria included the presence of any physical and/or psychological condition that could limit participation in exercise, as well as any circumstance that could prevent the child from completing self report measures during the evaluation (e.g., difficulties in understanding the forms, physical impairments, or illiteracy). The number of children to be included was calculated using the "Rasoft Sample Size Calculator." Assuming a child sexual abuse incidence rate of 1.4% within a population of 20,000 and an 80% confidence interval, the required sample size was determined to be 10 children per group¹⁴. Considering possible dropouts, 14 children were included in each of the three groups and randomly assigned to three groups equally. Allocation was performed using "Research Randomiser," program¹⁵. The interventions were conducted by the same physiotherapist, while evaluations were conducted by a different therapist. Both the children and the outcome assessor were blinded to group allocation.

Outcome Measures

All participants' demographic and clinical characteristics were assessed using a Socio-demographic Characteristics Questionnaire. Following this, several standardized measures were applied at baseline and after 3 months. The Adolescent Dissociative Experiences Scale (A-DES) was used to evaluate psychiatric symptoms that may arise following sexual abuse; the Physical Activity Questionnaire for Older Children (PAQ-C) was preferred to assess physical activity levels; and the Trunk Lateral Flexion Test was conducted to evaluate flexibility as a parameter of physical fitness.

The Adolescent Dissociative Experiences Scale (A-DES): Developed to identify dissociative symptoms in children aged 11 to 17 years. Dissociative experiences are classified into four domains: amnesia, absorption, derealization/ depersonalization, and imaginative involvement. The scale consists of 30 items, and responses rate each item on a scale from 0 to 10. Each item is rated on a scale with a maximum score of 10, where higher scores reflect greater severity of dissociative symptoms. For scoring purposes, the sum of all item scores is divided by the total number of items to obtain the overall score¹⁶. The scale was adapted into the Turkish version by Zoroğlu et al¹⁷.

The Physical Activity Questionnaire for Older Children (PAQ-C): Developed to assess the physical activity levels of children and adolescents, as well as the frequency of these activities. The questionnaire consists of nine items that evaluate activities performed during the previous seven days. Responses are scored using a five-point Likert scale, with each item receiving a minimum score of 1 and a maximum score of 5. Thus, total scores range from 9 to 45, with higher scores indicating greater levels of physical activity and the scale typically requires approximately 40 minutes to complete. Validity and reliability for use in Türkiye were established by Sert et al. (2014)^{18,19}.

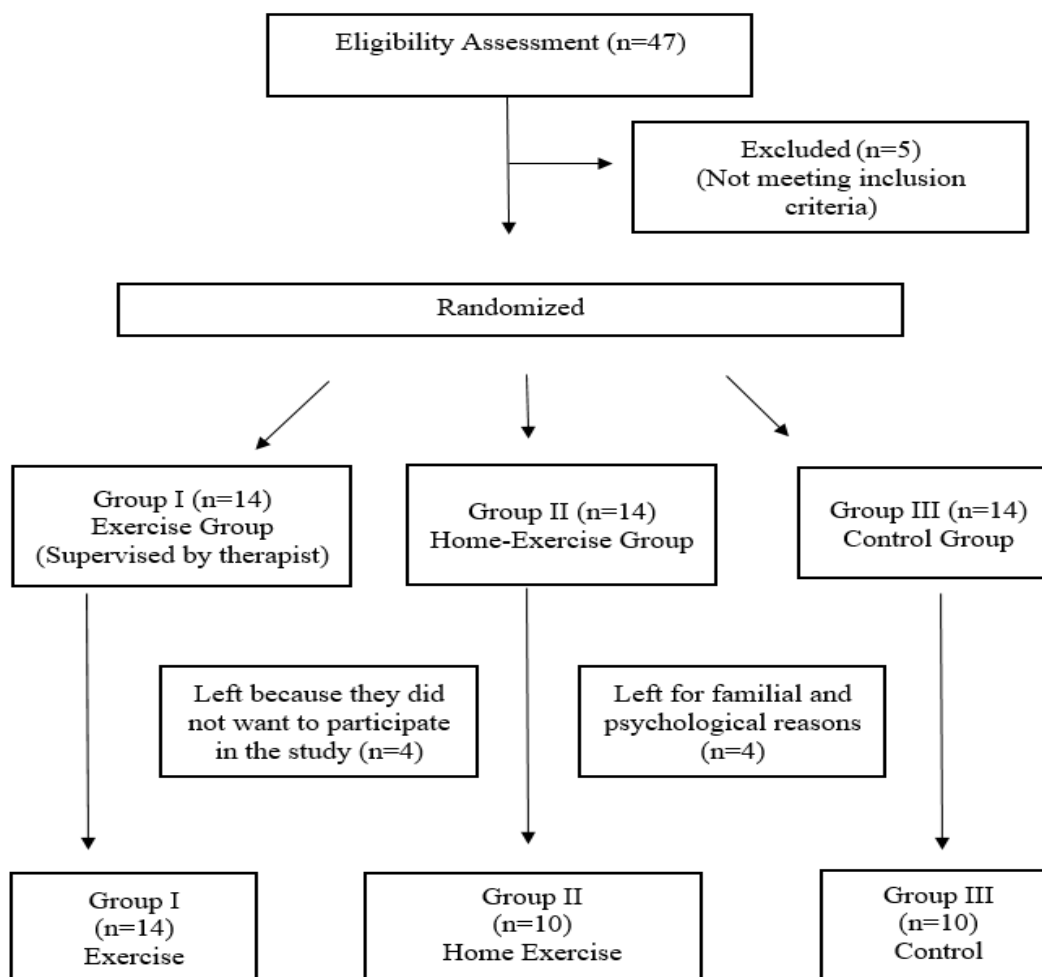
For the ***Trunk Lateral Flexion Test***, children were instructed to stand with their feet slightly apart and parallel, with their arms resting alongside the body. First, the location reached by the distal tip of the third finger on the thigh was marked. The child was then

asked to perform lateral flexion, and the new position of the fingertip was marked. The distance between the two points was measured using a tape measure²⁰. The assessment was conducted at two time points, namely prior to the intervention and upon completion of the treatment, and changes between these measurements were subsequently documented.

Procedures

The process of participant inclusion was given in Figure 1. In the first group including 14 children, therapist-supervised sessions were applied twice weekly for 12 weeks, each lasting 40 minutes and including a 10 minute warm-up, a 20 minute aerobic exercise program, and a 10 minute cool down. The second group, including 10 children, received the same exercises as home-based intervention and was provided with instructional brochures. The initial sessions were conducted with a physiotherapist to ensure proper instruction, and adherence was monitored using a checklist. The third group, also including 10 children, served as the control group, in which only the assessment scales and tests were administered at baseline and after 12 weeks.

Figure 1. Clinical Diagram of the Study



Exercise Programme

The exercise program was scheduled for two sessions per week over a 12-weeks period. Each session lasted 40 minutes and included a 10 minutes warm up, 20 minutes of aerobic exercise, and a 10 minutes cool down (stretching), all conducted under the supervision of a physical therapist. The aerobic exercise program was structured as circuit-based exercises performed under the supervision of a physical therapist. During the first 6 weeks, each exercise was performed for 8 repetitions, while during the following 6 weeks the repetitions were increased to 10 in order to provide gradual progression according to participants' adaptation and tolerance. During exercises, breathing control was emphasized throughout all exercises, and rest periods were provided between exercise transitions to prevent excessive fatigue and ensure participant safety.

Adherence to the supervised exercise program was high, and no participant dropout occurred in the physiotherapist-supervised exercise group, whereas some dropout was observed in the home exercise group. In cases where participants missed a session, a compensatory session was scheduled on another day within the same week. Additionally, no complications or adverse effects related to the intervention were observed during the study period. Detailed illustrations and names of the exercises are also provided in Appendix 1 (Appendix 1).

Ethical Statements

Ethical approval was obtained from the Clinical Research Ethics Committee of İstanbul Bakırköy Prof. Dr. Mazhar Osman Mental Health and Neurological Diseases Training and Research Hospital with the approval number of 2018/234, and written informed consent was obtained from all participating children before enrollment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki governing research involving human participants.

Statistical Analysis

SPSS version 20.0 for Windows was used in all statistical analyses. The normality for the data distribution was assessed using the Kolmogorov–Smirnov test. As many variables did not meet the assumptions of normal distribution, non-parametric tests were employed. Categorical variables were compared using the Chi-square test. Demographic and clinical characteristics of the groups were evaluated with the KruskalWallis test. The Wilcoxon Signed Ranks Test was used to compare pre- and post-treatment values within each group. Between-group comparisons were conducted using the KruskalWallis test, and when significant differences were identified, the Mann Whitney U test with Bonferroni correction was applied. The error level for post hoc analyses was set at $p < 0.01$, and the overall statistical significance level was accepted as $p < 0.05$.

Results

A total of 47 children were evaluated, of whom 5 were excluded for not meeting the inclusion criteria, and the remaining were randomly assigned to three groups. Following randomization, 4 children declined participation and 4 discontinued due to family or psychological reasons. Consequently, 34 of them completed the study: 14 in the physiotherapist-guided exercise group (Group 1), 10 in the home-exercise group (Group 2), and 10 in the control group (Group 3). All children in the exercise groups attended their scheduled treatment sessions twice weekly for twelve weeks in the clinical setting.

There were no statistically significant differences in mean age among the groups (14.86 ± 1.51 for group 1, 14.60 ± 2.01 for group 2, and 14.60 ± 2.12 for group 3; $p=0.83$). Similarly, no significant differences were found between the groups regarding other socio-demographic or clinical data, including school attendance, family structure, the educational and mental health status of parents ($p>0.05$) (Table 1).

Table 1. Distribution of the cases according to age, school attendance, family structure, educational and mental status of parents.

		Group 1	Group 2	Group 3	p
Child Age (Year) (Mean $\pm$ SD)		14.86 $\pm$ 1.51	14.60 $\pm$ 2.01	14.60 $\pm$ 2.12	0.83
School Attendance n(%)	No	1 (%7.1)	3 (%30)	2 (%20)	0.34
	Yes	13 (%92.9)	7 (%70)	8 (%80)	
Family Structure n(%)	Small	8 (%57.1)	8 (%80)	8 (%80)	0.56
	One Parent	4 (%28.6)	2 (%20)	1 (%10)	
	Step Mother/ Father	2 (%14.3)	-	1 (%10)	
Mother Education n(%)	Illiterate	2 (%14.3)	-	-	0.50
	Literate	3 (%21.4)	1 (%10)	1 (%10)	
	Primary education	4 (%28.6)	3 (%30)	3 (%30)	
	Secondary education	3 (%21.4)	2 (%20)	5 (%50)	
	High School	2 (%14.3)	3 (%30)	1 (%10)	
	University	-	1 (%10)	-	
Father Education n(%)	Illiterate	1 (%7.1)	-	-	
	Literate	1 (%7.1)	1 (%10)	-	

	Primary education	5 (%35.7)	3 (%30)	2 (%20)	0.25
	Secondary education	6 (%42.9)	1 (%10)	2 (%20)	
	High School	1 (%7.1)	5 (%50)	5 (%50)	
	University	-	-	1 (%10)	
Mother Mental Problem n(%)	Yes	3 (%21.4)	3 (%30)	3 (%30)	0.86
	No	11 (%78.6)	7 (%70)	7 (%70)	
Father Mental Problem n(%)	Yes	1 (%7.1)	2 (%20)	1 (%10)	0.62
	No	13 (%92.9)	8(%80)	9 (%90)	

Group 1= Exercise Group; Group 2= Home Exercise Group; Group 3= Control Group; SD: Standart Deviation; $p<0.05$

According to the results of the Physical Activity Questionnaire for Older Children (PAQ-C), no statistically significant differences were observed either within groups or between groups ($p>0.05$) (Table 2). Although all groups demonstrated statistically significant improvements in the trunk lateral flexion test ($p<0.05$), no group showed superiority over the others in the intergroup comparisons ($p>0.05$) (Table 2).

Table 2. Comparison of the mean values of PAQ-C and Trunk lateral flexion within and between groups.

	Pre-test Mean±SD	Post-test Mean±SD	Willcoxon Signed Ranks p	Intra-group Difference Mean [%95CI]	Kruskal-Wallis		
					P	Bonferonni	
						Grup	p*
The Physical Activity Questionnaire for Older Children (PAQ-C)							
Group 1	18.70±742	19.29±5.79	0.97	-0.59[-5,09-3,91]	1-3	0.41	
Group 2	18.49±5,92	17.93±3.54	0.91	0.56[-2,84-3,96]	0.77	2-3	0.77
Group 3	22.54±6.42	20.83±6.99	0.11	1.71[-0,45-3,88]		1-2	0.49
Trunk Lateral Flexion Test							
Group 1	10.82±2.58	12.00±2.45	0.01	-1.18[-1.91-(-0.45)]		1-3	0.24
Group 2	11.10±2.56	12.80±2.49	0.007	-1.70[-2.53-(-0.87)]	0.38	2-3	0.38
Group 3	10.60±2.22	12.40±1.84	0.005	-1.80[-2.36-(-1.24)]		1-2	0.54

Group 1= Exercise Group; Group 2= Home Exercise Group; Group 3= Control Group; SD: Standart Deviation; CI: Confidence Interval; $p<0.05$

The Adolescent Dissociative Experiences Scale (A-DES) scores showed no statistically significant changes from pre- to post-treatment within any of the groups, nor were any significant differences observed in comparisons between the groups ($p>0.05$) (Table 3).

Table 3. Comparison of the mean values of A-DES within and between groups.

	Pre-test Mean±SD	Post-test Mean±SD	Willcoxo n Signed Ranks p	Intra-group Difference Mean [%95CI]	Kruskal-Wallis		
					P	Bonferonni	
						Group	p*
The Adolescent Dissociative Experiences Scale (A-DES)							
Group 1	3.46±2.22	3.24±2.27	0.47	0.23[-0.53-0.99]	1-3	0.97	
Group 2	3.13±1.45	2.82±1.49	0.07	0.32[-0.03-0.66]	0.83	2-3	0.83
Group 3	3.09±2.52	2.91±2.59	0.28	0.17[-0.49-0.85]		1-2	0.85

Group 1=Exercise Group; Group 2=Home Exercise Group; Group 3=Control Group; SD: Standart Deviation; CI: Confidence Interval; p<0.05

Discussion

The aim of our study was to investigate the effects of physiotherapy-based aerobic exercises on post-traumatic stress–related outcomes such as dissociative experiences, physical activity level and physical fitness in children who had experienced sexual abuse. We hypothesized that the antidepressant effects of aerobic exercise would lead to meaningful improvements in persistent post-traumatic symptoms and in selected physical fitness parameters. Although within-group improvements were observed particularly in flexibility, as reflected in lateral flexion values, aerobic exercise did not demonstrate superiority over the other groups in dissociative experiences or physical activity levels. Thus, the null hypothesis was accepted.

Research has shown that physical activity may exert a protective influence on the association between adverse childhood experiences and subsequent health outcomes^{4,21,22}. In a study involving women with a history of childhood sexual abuse, heart rates were measured both before and after treadmill exercise. The findings indicated that individuals with a history of abuse were unable to achieve the expected rate of transition from an immobilized state to movement through sudden vagal activation, nor could they return to resting heart rate at the anticipated speed. This suggests that individuals with a history of abuse yield delays in the timing of fight or flight responses during stress²³. In another study where individuals were diagnosed with major depression, an eight-week aerobic exercise program led to improvements in reaction times, focusing on the positive effect of aerobic exercise on cognitive control²⁴. Another study closely aligned with ours, children aged 8–11 years who had experienced sexual abuse were included, and an eight-week physical exercise program was reported to produce significant improvements—particularly in anxiety and several related parameters—when compared with the control group²⁵. These kinds of studies indicate that survivors of sexual abuse show not only psychological but also physiological symptoms, stating the need to integrate physical interventions into their treatment. In

our study, aerobic exercises adapted for children were performed with shorter session durations and included warm-up and cool-down periods minimizing the risk of sudden increases in heart rate. Physical activity levels were assessed before and after the exercise protocol using the Physical Activity Questionnaire for Older Children (PAQ-C), as recommended by Voss et al. (2017) in their study on 84 children with congenital heart disease and by Erdim et al. (2019) in their application of the scale among 784 children aged 9–14 years in Türkiye^{26,27}. Scale results indicated the increases in physical activity levels were not found to be significant either within or between groups. The lack of significant differences may be due to the fact that the form assesses only activities performed during the previous seven days, with the initial evaluations coinciding with the school term and the final evaluations occurring during the summer holiday period.

Because of the severe psychological stress experienced following traumas such as sexual abuse, the resulting reduction in activity levels may lead to muscle shortening and increased stiffness, finally lowering overall flexibility²⁸. Supporting the evidence reported by researchers such as Czaprowski (2015) and Nakata et al. (2017), who examined physical fitness parameters in children and adolescents, the Trunk Lateral Flexion Test was also used in our study to assess flexibility^{29,30}. After the initial and final assessments, although all groups demonstrated significant improvements in Trunk Lateral Flexion values, no group showed a statistically superior change compared with the others. Several factors may be the reasons for these significant within-group gains in Trunk Lateral Flexion values together with the absence of statistically meaningful differences between groups. First, flexibility is known to be highly responsive to even low-intensity physical activity, daily functional movements, or the natural maturation process in children and adolescents; therefore, improvements may have occurred regardless of group allocation. Furthermore, the 12-week duration of the intervention, although sufficient to elicit measurable flexibility gains within groups, may not have been long enough to produce divergent trajectories strong enough to yield between-group significance. Finally, the aerobic exercise program performed may have been primarily oriented toward cardiovascular and psychological outcomes, with limited inclusion of stretching components specifically designed to enhance flexibility.

Dissociative identity disorder is defined in modern psychiatry as a chronic and polysymptomatic dissociative condition, in which childhood psychological trauma is considered to play a major etiological role³¹. The disorder may present with symptoms such as speaking as if one is a different person, inability to speak, fainting, amnesia, and disturbances in identity and consciousness. In a study conducted with women survivors of child sexual abuse, dance therapy was applied for the purpose of fostering reconnection with their bodies, enhancing bodily closeness, and creating a sense of freedom; the ones who received psychotherapy alongside dance therapy reported feeling more motivated and emotionally stronger than those in the control group³². In another study, the Dissociative Experiences Scale was administered to eight sexually abused women before and after an eight-session body awareness training program (one hour per session), and significant reductions in dissociative symptoms were observed following the intervention³³. Additionally, a previous research on Mental and Physical (MAP)

Training suggested that combining meditation with aerobic exercise reduced trauma-related cognitions and ruminations more effectively than either component alone¹³. These findings indicated that multicomponent interventions targeting both cognitive–emotional processes and physiological arousal might have been more effective in modifying dissociative or trauma-linked symptoms than exercise-only protocols. In this study, no significant differences were observed in the Adolescent Dissociative Experiences Scale scores either within or between the groups. This outcome may have been affected by the difficulty of resolving disturbances in consciousness, memory, and identity within a relatively short 12-week intervention period with exercise alone, as well as by the possibility that children avoided responding accurately due to concerns about being judged or had difficulty understanding some of the items.

The main limitation of this study is the small sample size, which resulted from the limited number of children with sexual abuse who could be reached and made robust randomization difficult. In addition, only female participants were included, and all participants were recruited from a single center and region, which limits the generalizability of the findings. Some eligible individuals also declined to participate or dropped out during the intervention, leading to further sample loss. Another limitation is that the assessments reflect only short-term outcomes. Moreover, differences in symptom severity and the interaction between the physiotherapist and the child may have influenced the results. As a final limitation, trauma-related characteristics of the participants, such as the identity of the perpetrator and the presence of penetration, could not be accessed due to institutional procedures, ethical considerations, and legal confidentiality regulations. Therefore, these variables could not be included in the analyses or evaluated as potential influencing factors. Although these limitations are important, this study contributes to the limited randomized controlled research examining both psychiatric and physical fitness outcomes of aerobic exercise interventions in children who have experienced sexual abuse.

Conclusion

This randomized controlled study examined the effects of physiotherapy-based aerobic exercise delivered under supervision or as a home program on dissociative symptoms, physical activity level and flexibility in children who were exposed to sexual abuse. Improvements in trunk lateral flexion were observed across all groups, suggesting a general effect that may not be specific to the exercise intervention. In contrast, no significant changes were detected in dissociative experiences or physical activity levels, possibly reflecting the complexity of trauma-related symptoms and the limitations of short-term interventions. Overall, these results suggest that aerobic exercise, particularly when integrated into treatment programs, may serve as a supportive approach to improve quality of life in this population. Future studies with larger samples, broader inclusion criteria, and longer follow-up periods are warranted to better clarify its role within multimodal treatment strategies.

Declaration of Interest Statement: There were no conflicts of interest.

Data Availability: Data will be made available on request.

REFERENCES

1. Stoltenborgh M, Van Ijzendoorn MH, Euser EM, Bakermans-Kranenburg MJ. A global perspective on child sexual abuse: Meta-analysis of prevalence around the world. *Child Maltreatment*. 2011;16(2):79-101.
2. Liu RT. Childhood maltreatment and impulsivity: A meta-analysis and recommendations for future study. *Journal of Abnormal Child Psychology*. 2019;47(2):221-243.
3. Amado BG, Arce R, Herraiz A. Psychological injury in victims of child sexual abuse: A meta-analytic review. *Psychosocial Intervention*. 2015;24(1):49-62.
4. Danese A, Tan M. Childhood maltreatment and obesity: Systematic review and meta-analysis. *Molecular Psychiatry*. 2014;19(5):544-554.
5. Molero-Zafra M, Fernández-García O, Mitjans-Lafont MT, Pérez-Marín M, Hernández-Jiménez MJ. Psychological intervention in women victims of childhood sexual abuse: A randomized controlled clinical trial comparing EMDR psychotherapy and trauma-focused cognitive behavioral therapy. *Frontiers in Psychiatry*. 2024;15:1360388.
6. Lavania C, Ballal D. The application of expressive art therapies for survivors of child sexual abuse. *Psychological Trauma: Theory, Research, Practice, and Policy*. 2025;17(1):1-12.
7. Amilhau A, Ferrandez S, Soubelet A. Massage therapy for survivors of rape and sexual abuse: A systematic review. *European Journal of Trauma & Dissociation*. 2024;8(2):100410. doi: 10.1016/j.ejtd.2024.100410.
8. Field T, Hernandez-Reif M, Diego M, Schanberg S, Kuhn C. Cortisol decreases and serotonin and dopamine increase following massage therapy. *International Journal of Neuroscience*. 2005;115(10):1397-1413.
9. Price C. Body-oriented therapy in recovery from child sexual abuse: An efficacy study. *Alternative Therapies in Health and Medicine*. 2005;11(5):46-57.
10. McTavish JR, Santesso N, Amin A, et al. Psychosocial interventions for responding to child sexual abuse: A systematic review. *Child Abuse & Neglect*. 2021;116:104203.

11. Isik O, Gokdemir K, Bastik C, Yildirim I, Dogan I. Elit gürüşçiler üzerine bir çalışma: Ağırılık kaybı ve depresyon. *Beden Eğitimi ve Spor Bilimleri Dergisi*. 2013;7(3):216-223.
12. Pritchett RV, Daley AJ, Jolly K. Does aerobic exercise reduce postpartum depressive symptoms? A systematic review and meta-analysis. *British Journal of General Practice*. 2017;67(663):e684-e691. doi: 10.3399/bjgp17X692525.
13. Shors TJ, Chang HY, Millon EM. MAP Training My Brain™: Meditation plus aerobic exercise lessens trauma of sexual violence more than either activity alone. *Frontiers in Neuroscience*. 2018;12:211. doi: 10.3389/fnins.2018.00211.
14. Aktepe E. Çocukluk çağı cinsel istismarı. *Psikiyatride Güncel Yaklaşımlar*. 2009;1(2):95-119.
15. Randomizer.org. Research Randomizer. Randomizer.org. <https://www.randomizer.org>. Published 1997. Updated n.d. Accessed 2023 Oct 20.
16. Armstrong JG, Putnam FW, Carlson EB, Libero DZ, Smith SR. Development and validation of a measure of adolescent dissociation: The Adolescent Dissociative Experiences Scale. *The Journal of Nervous and Mental Disease*. 1997;185(8):491-497.
17. Zoroglu SS, Tuzun U, Ozturk M, Sar V. Reliability and validity of the Turkish version of the Child Dissociative Checklist. *Journal of Trauma & Dissociation*. 2002;3(1):37-49.
18. Kowalski KC, Crocker PR, Donen RM. The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual. Saskatoon: University of Saskatchewan; 2004.
19. Emlek Sert ZU, Bayik Temel A. İlköğretim öğrencileri için fiziksel aktivite soru formunun Türk toplumuna uyarlanması: Geçerlilik ve güvenilirlik çalışması. *Dokuz Eylül Üniversitesi Hemşirelik Yüksekokulu Elektronik Dergisi*. 2014;7(2):109-114.
20. Otman AS, Demirel H, Sade A. Tedavi hareketlerinde değerlendirme prensipleri. Ankara: Hacettepe Üniversitesi Yayınları; 2003.
21. Ryu S, Gao Z. The moderating effects of physical activity on the relationships between child maltreatment and health outcomes among Korean adolescents: A secondary analysis of the 2020 Korean Children and Youth Rights Survey. *Journal of Clinical Medicine*. 2023;12(3):1054.

22. Hughes K, Bellis MA, Hardcastle K, et al. The effect of multiple adverse childhood experiences on health: A systematic review and meta-analysis. *The Lancet Public Health*. 2017;2(8):e356-e366. doi: 10.1016/S2468-2667(17)30118-4
23. Dale LP, Carroll LE, Galen G, Hayes JA, Webb KW, Porges SW. Abuse history is related to autonomic regulation to mild exercise and psychological wellbeing. *Applied Psychophysiology and Biofeedback*. 2009;34(4):299-308.
24. Olson RL, Brush CJ, Ehmann PJ, Alderman BL. A randomized trial of aerobic exercise on cognitive control in major depression. *Clinical Neurophysiology*. 2017;128(6):903-913.
25. Naderi S, Naderi S, Delavar A, Dortaj F. The effect of physical exercise on anxiety among the victims of child abuse. *Sport Sciences for Health*. 2019;15(3):519-525.
26. Voss C, Dean PH, Gardner RF, Duncombe SL, Harris KC. Validity and reliability of the Physical Activity Questionnaire for Children (PAQ-C) and Adolescents (PAQ-A) in individuals with congenital heart disease. *PLoS One*. 2017;12(4):e0175806.
27. Erdim L, Ergun A, Kuguoglu S. Reliability and validity of the Turkish version of the Physical Activity Questionnaire for Older Children (PAQ-C). *Turkish Journal of Medical Sciences*. 2019;49(1):162-169.
28. Huang HM, Wu MC, Chen KH. Effectiveness of a school weight control program. *Hu Li Za Zhi*. 2010;57(3):51-59.
29. Czaprowski D, Kedra A, Pawlowska P, et al. The examination of the musculoskeletal system based only on the evaluation of pelvic-hip complex muscle and trunk flexibility may lead to failure to screen children for generalized joint hypermobility. *PLoS One*. 2015;10(3):e0121360. doi: 10.1371/journal.pone.0121360
30. Nakata H, Akido M, Naruse K, Fujiwara M. Relative age effect in physical fitness among elementary and junior high school students. *Perceptual and Motor Skills*. 2017;124(5):900-911.
31. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Washington, DC: American Psychiatric Association; 2013.
32. Mills LJ, Daniluk JC. Her body speaks: The experience of dance therapy for women survivors of child sexual abuse. *Journal of Counseling & Development*. 2002;80(1):77-85.
33. Price C. Body-oriented therapy in sexual abuse recovery: A pilot-test comparison. *Journal of Bodywork and Movement Therapies*. 2006;10(1):58-64.

The Relationship between Trust in Nurses and Medication Adherence Among Individuals with Chronic Illnesses

Nadiye BARIŞ EREN*

Abstract

Aim: This study aimed to determine the relationship between trust in nurses and medication adherence among individuals with chronic diseases.

Method: This cross-sectional and correlational study was conducted between January and April 2025 with 358 individuals who applied to the internal medicine outpatient clinic of a state hospital. Data were collected using a Personal Information Form, the Trust in Nurses Scale, and the Modified Morisky Medication Adherence Scale. Descriptive statistics, Mann–Whitney U test, Kruskal–Wallis test, and Spearman correlation analysis were used for data analysis.

Results: The mean score of the Trust in Nurses Scale was 27.03 ± 4.29 , and the mean score of the Modified Morisky Medication Adherence Scale was 4.46 ± 1.53 . Significant differences were observed in trust in nurses according to duration of chronic illness, economic status, access to healthcare, perceived health status, presence of individuals with the same disease in the social environment, and frequency of physician visits ($p < 0.05$). Medication adherence differed significantly according to family type, disease-related knowledge, and frequency of physician visits ($p < 0.05$). A statistically significant positive correlation was found between trust in nurses and medication adherence ($r = 0.216$, $p < 0.001$).

Conclusion: The findings of the study demonstrated that there is a positive and significant relationship between trust in nurses and medication adherence among individuals with chronic diseases. Strengthening the trust relationship between nurses and patients may contribute to increased treatment adherence and improved health outcomes.

Keywords: Chronic disease, trust in nurses, medication adherence, nursing care, patient compliance.

Kronik Hastalığı Olan Bireylerde Hemşirelere Duyulan Güven ile İlaç Uyumu Arasındaki İlişki

Öz

Amaç: Bu çalışma, kronik hastalığı olan bireylerde hemşirelere güven ile ilaç uyumu arasındaki ilişkinin belirlenmesi amacıyla yapılmıştır.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 03.04.2026 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1922379>

* Asst. Prof., Tarsus University, Faculty of Health Science, Department of Nursing, Mersin, Türkiye.

E-mail: nbariseren@tarsus.edu.tr [ORCID https://orcid.org/0000-0002-1935-244X](https://orcid.org/0000-0002-1935-244X)

ETHICAL STATEMENT: Ethical approval for the study was obtained from the Noninvasive Clinical Research Ethics Committee (approval date: 27/11/2024, approval number: 2024/121). In addition, written permission was obtained from the institution where the study was conducted (approval date: 23/01/2025, approval number: 12).

Yöntem: Bu kesitsel ve ilişkisel araştırma, Ocak–Nisan 2025 tarihleri arasında bir devlet hastanesinin dahiliye polikliniğine başvuran 358 bireyin katılımıyla yürütülmüştür. Veriler; Kişisel Bilgi Formu, Hemşirelere Güven Ölçeği ve Modifiye Morisky İlaç Uyum Ölçeği kullanılarak toplanmıştır. Verilerin değerlendirilmesinde tanımlayıcı istatistikler ile birlikte Mann–Whitney U testi, Kruskal–Wallis testi ve Spearman korelasyon analizinden yararlanılmıştır.

Bulgular: Hemşirelere Güven Ölçeği puan ortalaması $27,03 \pm 4,29$, Modifiye Morisky İlaç Uyum Ölçeği puan ortalaması $4,46 \pm 1,53$ olarak bulunmuştur. Hemşirelere güvenin; kronik hastalık süresi, ekonomik durum, sağlık hizmetine ulaşım, sağlık algısı, çevrede aynı hastalığa sahip birey varlığı ve doktora gitme sıklığına göre anlamlı farklılık gösterdiği belirlenmiştir ($p < 0,05$). İlaç uyumunun ise aile tipi, hastalıkla ilgili bilgi varlığı ve doktora gitme sıklığına göre anlamlı düzeyde farklılık olduğu belirlenmiştir ($p < 0,05$). Hemşirelere güven ile ilaç uyumu arasında pozitif yönde ve istatistiksel açıdan anlamlı bir ilişki bulunmuştur ($r = 0,216$, $p < 0,001$).

Sonuç: Çalışma bulguları, kronik hastalığı olan bireylerde hemşirelere duyulan güven ile ilaç uyumu arasında pozitif yönlü ve anlamlı bir ilişki olduğunu göstermiştir. Hemşire-hasta arasındaki güven ilişkisinin güçlendirilmesi, tedavi uyumunun artırılmasına ve sağlık sonuçlarının iyileştirilmesine katkı sağlayabilir.

Anahtar Sözcükler: Kronik hastalık, hemşireye güven, ilaç uyumu, hemşirelik bakımı, hasta uyumu.

Introduction

Chronic diseases are considered a significant public health problem both worldwide and in Türkiye¹. With increasing life expectancy, the prevalence of chronic diseases has risen in recent years². These conditions require lifelong treatment and care, and adherence to treatment is a key factor in improving clinical outcomes^{3,4}.

Non-adherence to treatment is a well-documented problem among individuals with chronic diseases, with reported rates ranging from 22% to 93%⁵⁻⁸. Non-adherence leads to poor disease control, increased complications, and higher healthcare costs³.

Factors affecting treatment adherence include health literacy, medication costs, irregular medication use, concerns about medications, difficulties in accessing healthcare services, inadequate communication between healthcare professionals and patients, and beliefs that physicians prescribe excessive medications⁷⁻¹⁰. In this context, nurses play a critical role in improving treatment adherence by identifying barriers and facilitators and establishing trust-based relationships with patients¹¹⁻¹⁴.

According to Virginia Henderson's nursing theory, effective care requires a holistic approach addressing individuals' physiological, psychological, spiritual, sociocultural, and developmental needs, and trust forms the foundation of the nurse–patient relationship.¹¹ Nurses' professional competence, communication skills, and caring behaviors are key determinants of patients' trust in nurses¹⁵.

A strong trust relationship enhances patient participation, strengthens communication, and supports adherence to treatment recommendations^{13,16}. In addition, shared decision-making processes have been reported to positively influence adherence^{17,18}. Furthermore, trust in nurses has been found to be positively associated with perceived

quality of care¹⁹, and nurse-led interventions have been shown to improve both trust and medication adherence^{20,21}.

Although many studies have examined factors affecting treatment adherence and nurse-related variables, studies directly investigating the relationship between trust in nurses and medication adherence remain limited^{22,23}.

This study aims to determine the relationship between trust in nurses and medication adherence among individuals with chronic diseases.

Research Questions:

- 1: Is there a relationship between trust in nurses and medication adherence among individuals with chronic diseases?
- 2: Does trust in nurses differ according to the sociodemographic characteristics of individuals with chronic diseases?
- 3: Does medication adherence differ according to the sociodemographic characteristics of individuals with chronic diseases?

Material and Methods

Study Design

This study was conducted as a cross-sectional and correlational descriptive study.

Setting and Time

The study was carried out in the internal medicine outpatient clinic of a state hospital between January and April 2025.

Population and Sample

The population of this study comprised patients who attended the internal medicine outpatient clinic of a state hospital within the defined study period.

The sample size was calculated based on a correlation analysis designed to investigate the relationship between trust in nurses and medication adherence. Previous research has indicated that the associations between medication adherence and its related factors in individuals with chronic diseases are typically weak to moderate²⁴. Therefore, the effect size was accepted as $r=0.15$. According to Cohen (1988), correlation coefficients of 0.10, 0.30, and 0.50 represent small, medium, and large effect sizes, respectively²⁵.

Assuming a significance level of $\alpha=0.05$ and a statistical power of $(1-\beta)=0.80$, the minimum required sample size was determined to be 347 participants. To compensate for potential data loss, it was planned to recruit a larger number of participants than the

minimum requirement. Accordingly, all eligible individuals who consented to participate during the data collection period were included, and the study was finalized with a total of 358 participants.

Individuals who were 18 years of age or older, had a chronic disease, had been using medication for at least six months, voluntarily agreed to participate, were able to communicate verbally, and had no mental impairment were included in the study. Participants who did not meet the inclusion criteria were not included in the study.

Data Collection Instruments

Data were collected using the “Personal Information Form,” the “Trust in Nurses Scale,” and the “Modified Morisky Medication Adherence Scale.”

Personal Information Form: This form was developed by the researcher in line with the literature^{8,26,27}. It consists of a total of 21 items, including information on participants' sociodemographic characteristics and their chronic diseases.

Trust in Nurses Scale: The scale was developed by Radwin and Cabral in 2010²⁸, and its Turkish validity and reliability study was conducted by Yücel and Ay in 2013²⁹. The Cronbach's alpha coefficient of the Turkish version was reported as 0.95. In the version adapted for the general patient population, İspir Demir et al.²⁶ reported a Cronbach's alpha value of 0.89. In the present study, Cronbach's alpha coefficient was 0.951. This scale is used to assess individuals' level of trust in nurses. It is a single-dimensional, 6-point Likert-type scale consisting of five items, with response options ranging from “never” to “always.” The total score ranges from 5 to 30, with higher scores indicating a higher level of trust in nurses. The scale does not have an established cut-off point for categorizing trust levels.

Modified Morisky Medication Adherence Scale: The scale was developed by adding two items to the scale originally created by Morisky et al., in 1986³⁰ and is used to assess medication adherence among individuals with chronic diseases. The Turkish validity and reliability study of the scale was conducted by Vural et al. in 2012³¹, and the Cronbach's alpha coefficient was reported as 0.64. In the present study, Cronbach's alpha coefficient was 0.646. The scale consists of six dichotomous (yes/no) items and evaluates individuals' levels of motivation and knowledge regarding medication use. For items 2 and 5, a “yes” response is scored as 1 and a “no” response as 0, whereas the scoring is reversed for the remaining items (yes = 0, no = 1). The scale comprises two subscales: motivation (items 1, 2, and 6) and knowledge (items 3, 4, and 5), each with a possible score ranging from 0 to 3. Scores of 0–1 indicate low and 2–3 indicate high levels of motivation or knowledge. In the present study, a total score ranging from 0 to 6 was also calculated, with higher scores indicating better medication adherence, consistent with previous research using the Turkish version of the scale^{31,32}.

Data Collection Procedure

Data were collected by the researcher between January and April 2025 in the internal medicine outpatient clinic of a state hospital. Individuals who met the inclusion criteria and agreed to participate voluntarily were included in the study. Before data collection, participants were informed about the purpose and procedures of the study, and written and verbal informed consent was obtained. Data were collected through face-to-face interviewer-administered interviews using a structured questionnaire form. Completion of the questionnaire required approximately 10–15 minutes.

Ethical Considerations

Ethical approval for the study was obtained from the Noninvasive Clinical Research Ethics Committee (approval date: 27/11/2024, approval number: 2024/121). In addition, written permission was obtained from the institution where the study was conducted (approval date: 23/01/2025, approval number: 12). Participants were informed about the study, and both written and verbal informed consent were obtained based on voluntary participation. The confidentiality of the participants was ensured, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Data Analysis

Statistical analyses were performed using the SPSS version 23.0 software. The significance level was accepted as $p < 0.05$. The distribution of the data was evaluated with the Shapiro–Wilk test, which indicated that the variables did not follow a normal distribution. Accordingly, non-parametric methods were preferred. The Mann–Whitney U test was applied for comparisons between two independent groups, while the Kruskal–Wallis test was used for comparisons involving more than two groups. When a statistically significant Kruskal–Wallis test result was obtained, post hoc pairwise comparisons with Bonferroni-adjusted p values were conducted to determine which groups differed significantly. Associations between continuous variables were analyzed using Spearman’s correlation coefficient. Descriptive data were expressed as mean, standard deviation, frequency, and percentage.

Results

According to Table 1, the most common chronic diseases were hypertension (49.2%) and diabetes (44.4%), followed by heart disease (21.5%). Regarding disease duration, 24.3% of the participants had a chronic disease for 1–5 years, while 28.8% had a duration of 6–10 years. The majority of participants were aged 61–70 years (31.0%).

Table 1. Distribution of participants according to demographic characteristics.			
Variables		n	%
Age	≤40 years	26	7.3
	41-50	50	14.0
	51-60	72	20.1
	61-70	111	31.0
	71-80	76	21.2
	≥80 years	23	6.4
Gender	Female	189	52.8
	Male	169	47.2
Marital Status	Married	325	90.8
	Single	33	9.2
Chronic Diseases	Asthma	12	3.4
	DM	159	44.4
	HT	176	49.2
	Heart Disease	77	21.5
	CKD	17	4.7
	COPD	32	8.9
	Other*	66	18.4
Duration of Chronic Disease	Less than 1 year	12	3.4
	1-5 years	87	24.3
	6-10 years	103	28.8
	11-15 years	58	16.2
	16-20 years	54	15.1
	More than 20 years	44	12.3
Number of Children	0	31	8.7
	1	14	3.9
	2	75	20.9
	3	69	19.3
	≥4	169	47.2
Family Type	Nuclear family	266	74.3
	Extended family	88	24.6
	Other	4	1.1
Education Level	Illiterate	83	23.2
	Literate	11	3.1
	Primary school	177	49.4
	Secondary school	34	9.5
	High school	30	8.4
	University	23	6.4

Place of Residence	Village	85	23.7
	District	235	65.6
	City	38	10.6
Occupation	Unemployed	173	48.3
	Worker	33	9.2
	Civil servant	10	2.8
	Retired	131	36.6
	Other	11	3.1
Employment Status	Employed	52	14.5
	Unemployed	174	48.6
	Retired and working	20	5.6
	Retired and not working	112	31.3
Social Security	Yes	276	77.1
	No	82	22.9
Economic Status	Low	168	46.9
	Middle	178	49.7
	High	12	3.4
Access to Healthcare	Easy	255	71.2
	Difficult	103	28.8
Previous Hospitalization	Yes	336	93.9
	No	22	6.1
Hospitalization Due to Chronic Disease	Yes	190	56.5
	No	146	43.5
Perceived Health Status	Poor	76	21.2
	Moderate	194	54.2
	Good	88	24.6
Knowledge About Disease	Yes	284	79.3
	No	74	20.7
Received Education About Disease	Yes	118	33.0
	No	240	67.0
Presence of Similar Disease in Environment	Yes	252	70.4
	No	106	29.6
Frequency of Visiting Physician	Frequently	129	36.0
	Every 3 months	131	36.6
	Every 6 months	98	27.4
Total		358	100.0
n: Number; %: Percentage; DM: Diabetes Mellitus, HT: Hypertension, CKD: Chronic Kidney Failure, COPD: Chronic Obstructive Pulmonary Disease, Other*: Alzheimer's disease, anemia, bronchitis, dementia, epilepsy, familial Mediterranean fever (FMF), goiter, hyperthyroidism, hypothyroidism, lung cancer, colon cancer, lymphoma, migraine, pancreatitis, Parkinson's disease, prostate disease, rheumatic disease, cirrhosis, stroke (SVO), thalassemia, idiopathic thrombocytopenic purpura (ITP), vertigo, and hyperlipidemia.			

Of the participants, 52.8% were female and 90.8% were married, while 74.3% had a nuclear family structure. Nearly half of the participants were primary school graduates (49.4%) and 65.6% resided in districts. In terms of employment, 48.6% were not working and 31.3% were retired and not working, while 77.1% had social security. Regarding economic status, 46.9% reported low income and 49.7% reported moderate income. Additionally, 71.2% reported easy access to healthcare services.

A large proportion of participants (93.9%) had previous hospitalization experience, and 56.5% had been hospitalized due to their chronic disease. In terms of perceived health status, 54.2% reported moderate and 21.2% reported poor health. Most participants (79.3%) had knowledge about their disease, although 67.0% had not received formal education. Furthermore, 70.4% reported having individuals with the same disease in their environment. Regarding physician visits, 36.0% reported visiting frequently and 36.6% reported visiting every three months.

Table 2. Participants' mean scale scores (n=358).

Variables	X $\pm$ SD	Min-Max	Med	Cronbach's Alpha
Trust in Nurses Scale	27.03 $\pm$ 4.29	10-30	29	0.951
Modified Morisky Medication Adherence Scale	4.46 $\pm$ 1.53	0-6	5	0.646

X= Mean, SD= Standard deviation, Min-Max: Minimum-Maximum, Med: Median

The mean score of the Trust in Nurses Scale was 27.03 $\pm$ 4.29, and the mean score of the Modified Morisky Medication Adherence Scale was 4.46 $\pm$ 1.53.

Table 3. Comparison of scale scores according to participants' sociodemographic characteristics.

Variables			Trust in Nurses Scale				Modified Morisky Medication Adherence Scale			
			Med	X±SD	Test Value	p	Med	X±SD	Test Value	p
Chronic Diseases	Asthma	Yes	27.5	25.67±4.38	-1.583**	0.113	5	4.33±1.87	-0.003**	0.998
		No	30	27.07±4.29			5	4.47±1.52		
	DM	Yes	30	27.44±3.86	-1.396**	0.163	5	4.31±1.58	-1.649**	0.099
		No	29	26.69±4.59			5	4.58±1.48		
	HT	Yes	30	27.30±4.24	-1.520**	0.128	5	4.45±1.54	-0.148**	0.882
		No	29	26.76±4.34			5	4.47±1.52		
	Heart Disease	Yes	30	27.39±4.16	-1.163**	0.245	5	4.55±1.59	-0.787**	0.431
		No	29	26.93±4.33			5	4.44±1.51		
	CKD	Yes	30	28.06±3.85	-1.098**	0.272	6	4.88±1.41	-1.275**	0.202
		No	29	26.97±4.31			5	4.44±1.53		
	COPD	Yes	30	27.78±4.09	-1.364**	0.173	5	4.97±1.23	-1.927**	0.054
		No	29	26.95±4.31			5	4.41±1.55		
	Other*	Yes	30	27.21±3.99	-0.464**	0.642	5	4.71±1.44	-1.539**	0.124
		No	29	26.98±4.36			5	4.40±1.54		
Duration of Chronic Disease		Less than 1 year (0)	25	24.00±6.30	14.301***	0.014* 5>0	5.5	4.92±1.38	3.714***	0.591
		1-5 years (1)	29	27.21±3.86			5	4.51±1.49		
		6-10 years (2)	28	26.57±4.65			5	4.38±1.64		
		11- 15 years (3)	29.5	26.36±4.63			5	4.26±1.56		

	16-20 years (4)	30	27.69±4.09			5	4.44±1.49		
	20 yıldan fazla (5)	30	28.61±2.41			5	4.73±1.37		
Age	≤40 years	29.5	26.73±4.35	3.022***	0.697	5	4.88±1.40	5.333***	0.377
	41-50	28.5	27.16±3.92			5	4.36±1.61		
	51-60	30	27.29±3.92			5	4.49±1.56		
	61-70	29	26.41±4.93			5	4.30±1.57		
	71-80	30	27.45±4.21			5	4.64±1.45		
	≥80 years	29	27.78±2.84			5	4.30±1.43		
Gender	Female	29	27.05±4.13	-0.218**	0.828	5	4.41±1.54	-0.702**	0.483
	Male	30	27.00±4.48			5	4.51±1.52		
Marital Status	Married	30	27.08±4.29	-0.802**	0.423	5	4.44±1.54	-0.579**	0.563
	Single	28	26.48±4.35			5	4.64±1.43		
Number of Children	0	30	27.23±3.98	1.261***	0.868	5	4.77±1.50	8.300***	0.081
	1	30	28.29±2.20			4.5	4.71±1.14		
	2	30	27.48±3.57			5	4.68±1.45		
	3	29	27.09±3.92			5	4.68±1.33		
	≥4	29	26.66±4.87			4	4.20±1.63		
Family Type	Nuclear family (1)	30	27.29±4.01	3.269***	0.195	5	4.62±1.50	2.951***	0.002* 1>2
	Extended family (2)	28	26.31±4.90			4	4.01±1.49		
	Other (3)	28	25.25±6.90			4.5	3.75±2.63		
Education Level	Illiterate	28	26.46±4.57	7.265***	0.202	5	4.17±1.58	6.030***	0.303
	Literate	30	27.27±5.52			4	4.27±1.42		
	Primary school	30	27.43±4.22			5	4.54±1.56		
	Secondary school	28	26.71±4.10			5	4.68±1.39		
	High school	28	27.00±3.82			5	4.73±1.28		
	University	29	26.35±4.14			5	4.30±1.61		
Place of Residence	Village	30	27.46±4.40	2.217***	0.330	5	4.24±1.66	2.698***	0.259
	District	29	26.86±4.29			5	4.56±1.48		
	City	28.5	27.11±4.07			4	4.34±1.49		
Occupation	Unemployed	30	27.31±4.02	5.066***	0.281	5	4.38±1.58	7.544***	0.110
	Worker	28	26.42±4.15			4	4.00±1.54		
	Civil servant	27.5	26.00±5.16			5	4.80±1.23		
	Retired	30	27.05±4.48			5	4.62±1.44		
	Other	27	25.00±5.66			6	5.00±1.61		
Employment Status	Employed	28	26.12±4.63	3.614***	0.306	5	4.50±1.49	2.160***	0.540
	Unemployed	30	27.18±4.15			5	4.34±1.60		
	Retired and working	29.5	27.95±3.05			5	4.85±1.31		
	Retired and not working	30	27.04±4.51			5	4.55±1.46		
Social Security	Yes	29	26.81±4.51	-0.948**	0.343	5	4.52±1.53	-1.664**	0.096
	No	29.5	27.74±3.39			5	4.26±1.51		
Economic Status	Low (1)	30	27.67±3.71	7.397***	0.025* 1>2	5	4.52±1.52	4.005***	0.135
	Middle (2)	29	26.57±4.54			5	4.47±1.51		
	High (3)	28.5	24.75±6.38			4	3.58±1.68		
Access to Healthcare	Easy	30	27.57±3.39	-2.002**	0.045*	5	4.56±1.44	-1.594**	0.111
	Difficult	29	25.67±5.76			5	4.20±1.71		
Previous Hospitalization	Yes	29	27.02±4.32	-0.024**	0.981	5	4.45±1.54	-0.251**	0.802
	No	30	27.05±3.87			5	4.59±1.37		
	Yes	30	27.11±4.43	-0.802**	0.423	5	4.57±1.44	-1.335**	0.182

Hospitalization Due to Chronic Disease	No	29	26.92±4.19			5	4.29±1.65		
Perceived Health Status	Poor (1)	29	26.59±4.92	13.474***	0.001* 3>1, 3>2	5	4.37±1.54	0.603***	0.740
	Moderate (2)	28	26.57±4.46			5	4.46±1.54		
	Good (3)	30	28.40±2.85			5	4.53±1.50		
Knowledge About Disease	Yes	29	27.00±4.23	-0.516**	0.606	5	4.64±1.40	-3.809**	0.000*
	No	30	27.14±4.53			3	3.76±1.78		
Received Education About Disease	Yes	29.5	27.25±3.90	-0.278**	0.781	5	4.53±1.49	-0.613**	0.540
	No	29	26.92±4.47			5	4.43±1.55		
Presence of Similar Disease in Environment	Yes	30	27.50±3.74	-2.618**	0.009*	5	4.50±1.49	-0.529**	0.597
	No	28	25.89±5.22			5	4.37±1.62		
Frequency of Visiting Physician	Frequently (1)	30	28.12±2.93	8.354***	0.015* 1>3	5	4.71±1.39	13.886***	0.001* 1>3, 2>3
	Every 3 months (2)	29	26.60±4.60			5	4.58±1.49		
	Every 6 months (3)	29	26.15±5.06			4	3.97±1.64		

X= Mean, SD= Standard deviation, Med: Median, *p<0.05, **Mann Whitney U test, ***Kruskal Wallis test; DM: Diabetes Mellitus, HT: Hypertension, CKD: Chronic Kidney Failure, COPD: Chronic Obstructive Pulmonary Disease, Other*: Alzheimer's disease, anemia, bronchitis, dementia, epilepsy, familial Mediterranean fever (FMF), goiter, hyperthyroidism, hypothyroidism, lung cancer, colon cancer, lymphoma, migraine, pancreatitis, Parkinson's disease, prostate disease, rheumatic disease, cirrhosis, stroke (SVO), thalassemia, idiopathic thrombocytopenic purpura (ITP), vertigo, and hyperlipidemia.

The comparison of scale scores according to the demographic characteristics of the participants is presented in Table 3.

As shown in Table 3, Trust in Nurses Scale scores differed significantly according to duration of chronic disease, economic status, access to healthcare, perceived health status, presence of similar disease in the social environment, and frequency of physician visits (p<0.05). Post hoc analysis indicated that participants with a chronic disease duration of 20 years or more had higher scores compared to those with a duration of less than one year. Participants with low economic status and those who had easy access to healthcare services also had higher scores. In addition, individuals who perceived their health as good, those who had individuals with the similar disease in their environment, and those who visited physicians more frequently had higher trust scores.

Similarly, Modified Morisky Medication Adherence Scale scores differed significantly according to family type, disease-related knowledge, and frequency of physician visits (Table 3, p<0.05). Post hoc analysis revealed that participants with a nuclear family structure and those who had knowledge about their disease had higher adherence scores. In addition, participants who visited physicians frequently or every three months had higher scores compared to those who visited every six months.

Table 4. Relationship between the trust in nurses scale and the modified morisky medication adherence scale.

Variables	Trust in Nurses Scale	
	r	p
Modified Morisky Medication Adherence Scale	0.216	<0.001*

r: Spearman correlation coefficient, *p <0.001

As presented in Table 4, a statistically significant weak positive correlation was found between the Trust in Nurses Scale and the Modified Morisky Medication Adherence Scale (r=0.216, p<0.001).

Discussion

This study contributes to the literature by examining the relationship between trust in nurses and medication adherence among individuals with chronic diseases. The findings highlight the multidimensional nature of trust and treatment adherence within the nurse–patient relationship.

In this study, participants demonstrated a relatively high level of trust in nurses, consistent with previous findings¹⁵. This may be attributed to the frequent and continuous interactions between individuals with chronic diseases and healthcare professionals due to long-term care needs.

Another noteworthy finding is that medication adherence was also high. In contrast, previous studies have reported high rates of non-adherence among individuals with chronic diseases^{6,7}. This discrepancy may be explained by differences in sample characteristics, access to healthcare services, and levels of communication and trust with healthcare professionals.

Participants with a longer duration of chronic illness, lower economic status, easier access to healthcare, better perceived health status, the presence of similar chronic conditions in their social environment, and more frequent physician visits reported significantly higher trust in nurses. These findings may reflect the importance of sustained interactions between patients and nurses in developing trusting relationships, as well as the influence of individual and contextual factors on trust. Trust has been described as a dynamic process shaped by nurses' professional competence, interpersonal caring behaviours, and the continuity of the therapeutic relationship rather than as a static characteristic¹¹. Likewise, Taylor et al.³³ emphasized that trust in healthcare is a multidimensional and context-dependent construct that develops within ongoing relationships among patients, healthcare professionals, and healthcare organizations.

The association between a longer duration of chronic illness and higher trust in nurses is consistent with the concept that prolonged engagement with healthcare services provides greater opportunities for therapeutic interaction. Similarly, Kamimura et al.³⁴ reported that continuity of care was associated with stronger patient-provider relationships among vulnerable patients. Supporting this interpretation, Darby et al.³⁵ demonstrated that sustained nurse-led primary care significantly improved trust in healthcare providers, highlighting the importance of repeated and continuous contact in fostering trust. Therefore, patients living with chronic illnesses for longer periods may gradually develop greater confidence in nurses through repeated interactions and continuity of care.

Participants who reported easier access to healthcare also demonstrated higher trust in nurses. Although few studies have directly examined this relationship, easier access may facilitate regular contact with healthcare professionals and strengthen therapeutic relationships over time. This interpretation is consistent with Kamimura et al.³⁴, who emphasized the role of continuity of care in strengthening patient-provider relationships, and with the findings of Darby et al.³⁵, who showed that sustained nurse-patient interactions were associated with improved trust in healthcare providers.

Better perceived health status was also associated with higher trust in nurses. A similar pattern was reported by Kamimura et al.³⁴, who found that individuals with better self-rated health had more positive patient-provider relationships. Positive healthcare experiences, effective communication, and continuity of care may contribute simultaneously to both improved health perceptions and stronger trust in healthcare professionals.

Interestingly, participants with lower economic status reported higher trust in nurses. This finding differs from that of Lu et al.³⁶, who found that greater relative income deprivation was associated with lower trust in physicians among individuals with chronic diseases.

Participants who had family members or acquaintances with similar chronic conditions also reported higher trust in nurses. Although direct evidence regarding this association remains limited, previous experiences shared within patients' social networks may positively influence expectations of nursing care and increase confidence in healthcare professionals. Further research is needed to clarify the mechanisms underlying this relationship.

In contrast, trust in nurses did not differ according to chronic disease type in the present study, suggesting that patients' trust may be influenced more by the quality and continuity of nurse-patient interactions than by the specific chronic condition itself. Previous studies have reported mixed findings regarding demographic variables. While Ozaras and Abaan¹⁵ found higher trust among certain age groups and males, other studies have reported no significant differences according to demographic characteristics¹⁹.

Higher medication adherence was observed among individuals with a nuclear family structure, those with disease-related knowledge, and those who used healthcare services more frequently. These findings are consistent with the literature emphasizing the importance of social support, patient education, and regular interaction with healthcare professionals in relation to medication adherence¹⁰.

Individuals living in a nuclear family may have greater opportunities for support in managing treatment routines, which may be associated with better medication adherence. Similarly, participants with greater disease-related knowledge may be more aware of the importance of adhering to treatment recommendations and the potential consequences of non-adherence. More frequent use of healthcare services may also provide opportunities for regular follow-up, continuous education, and timely resolution of treatment-related concerns, which may support medication adherence.

The literature also indicates that clear information provided by healthcare professionals and regular follow-up are associated with improved medication adherence²⁴. In addition, Abel and Efird²² identified age and the number of medications as important factors associated with adherence. Although previous studies have reported differences in medication adherence according to chronic disease type²³, no significant association was found between chronic disease type and medication adherence in the present study. This discrepancy may be related to differences in study populations, disease characteristics, or healthcare settings.

A positive and statistically significant relationship was found between trust in nurses and medication adherence, consistent with previous studies^{22,23,37}. In addition, the high level of trust in nurses observed in this study may have contributed to better adherence behaviors.

Evidence from systematic reviews and meta-analyses further supports the role of nurse-led interventions in improving medication adherence and clinical outcomes^{21,38}. These interventions may enhance communication and strengthen trust between nurses and patients. In addition, nurses' active roles in medication management and patient education are considered important contributors to adherence, while lack of trust has been identified as a barrier³⁹.

However, the weak correlation found in this study suggests that medication adherence cannot be explained solely by trust in nurses and is influenced by multiple factors. Medication adherence is a multidimensional phenomenon shaped by individual, social, and healthcare systems-related variables. Therefore, although trust is important, it may not be sufficient alone.

The literature indicates that patient participation and shared decision-making processes are associated with treatment adherence¹⁷. This underscores the importance of active patient involvement in the treatment process. In addition, effective communication and trust-based relationships between healthcare professionals and patients are closely associated with adherence behaviors⁴⁰.

In this context, nurses should be considered not only as care providers but also as key facilitators of treatment adherence. Enhancing communication skills, increasing patients' knowledge about their disease, and establishing a trust-based care environment may support improved medication adherence.

The limited number of studies examining trust in nurses and medication adherence together suggests that this study provides a meaningful contribution to the literature. These findings indicate that trust and medication adherence are associated not only with individual factors but also with social and environmental determinants.

Limitations

This study has some limitations. Since the research was conducted using a cross-sectional design, it does not allow for establishing causal relationships between the variables. Data collected through self-report measures may have led to potential response bias. Furthermore, the fact that the study was carried out in a single center restricts the generalizability of the results.

Conclusion

This study found a positive and statistically significant relationship between trust in nurses and medication adherence among individuals with chronic diseases. The findings suggest that higher levels of trust in nurses are associated with higher levels of medication adherence. However, the weak strength of this relationship suggests that medication adherence is a multidimensional phenomenon and is associated with multiple factors beyond trust in nurses.

Trust in nurses differed according to duration of chronic illness, economic status, access to healthcare services, perceived health status, presence of individuals with similar diseases in the social environment, and frequency of physician visits. Medication adherence, on the other hand, varied according to family type, level of disease-related knowledge, and frequency of physician visits. These findings emphasize the importance of addressing nursing care within a multidimensional framework that includes individual, social, and environmental factors.

Based on these findings, the positive association between trust in nurses and medication adherence highlights the potential importance of fostering trusting nurse-patient relationships in the care of individuals with chronic diseases. In addition, disease-related knowledge and regular physician follow-up should be considered when addressing medication adherence among individuals with chronic diseases.

Recommendations

Future research should examine this relationship using longitudinal or experimental designs and investigate the associated factors using more comprehensive models. In addition, future studies should examine additional factors that may influence medication

adherence in conjunction with trust in nurses to provide a more comprehensive understanding of medication adherence among individuals with chronic diseases.

REFERENCES

1. Türkiye İstatistik Kurumu. İstatistiklerle yaşlılar, 2021. Türkiye İstatistik Kurumu. <https://data.tuik.gov.tr/Bulten/Index?p=İstatistiklerle-Yaslılar-2021-45636>. Published March 18, 2022. Accessed October 1, 2024.
2. Aydemir Ç, Çetin Ş. Kronik hastalıklar ve psikososyal bakım. *JAMER*. 2019;4(3):109-115.
3. Neiman AB, Ruppar T, Ho M, et al. CDC Grand Rounds: Improving medication adherence for chronic disease management—innovations and opportunities. *MMWR Morb Mortal Wkly Rep*. 2017;66(45):1248-1251. doi:10.15585/mmwr.mm6645a2.
4. World Health Organization. Noncommunicable diseases. World Health Organization. <https://www.who.int/health-topics/noncommunicable-diseases>. Published 2018. Accessed October 1, 2024.
5. Bhattarai B, Walpola R, Mey A, Anoopkumar-Dukie S, Khan S. Barriers and strategies for improving medication adherence among people living with COPD: A systematic review. *Respir Care*. 2020;65(11):1738-1750. doi:10.4187/respcare.07355.
6. Demirel M, Sukut Ö. Kronik böbrek yetmezliği olan hastalarda psikolojik sağlık, algılanan sosyal destek ve depresyon ile tedaviye uyum arasındaki ilişki. *SBÜHD*. 2024;6(1):49-56. doi:10.48071/sbuhemsirelik.1363343.
7. Su Y, Wang X, Xing Y, et al. The analysis of factors affecting medication adherence in patients with myasthenia gravis: A cross-sectional study. *Ther Adv Neurol Disord*. 2024;17:17562864231206877. doi:10.1177/17562864231206877.
8. Unal E, Cinar FI, Porucu C. Factors affecting medication adherence in patients using oral chemotherapy: A descriptive study. *J Oncol Pharm Pract*. Published 2025;31(3):412-421. doi:10.1177/10781552241241059.
9. Moore SG, Richter G, Modjtahedi BS. Factors affecting glaucoma medication adherence and interventions to improve adherence: A narrative review. *Ophthalmol Ther*. 2023;12(6):2863-2880. doi:10.1007/s40123-023-00797-8.
10. Patel S, Huang M, Miliara S. Understanding treatment adherence in chronic diseases: Challenges, consequences, and strategies for improvement. *J Clin Med*. 2025;14(17):6034. doi:10.3390/jcm14176034.

11. Dinç L, Gastmans C. Trust in nurse-patient relationships: A literature review. *Nurs Ethics*. 2013;20(5):501-516. doi:10.1177/0969733012468463.
12. Ruswati R. The role of nurses in enhancing medication adherence and patient outcomes in hypertension management. *Int J Nurs Midwifery Res*. 2024;2(3):78-87. doi:10.35335/ners.v2i3.286.
13. Shanahan T, Cunningham J. Keys to trust-building with patients. *J Christ Nurs*. 2021;38(2):E11-E14. doi:10.1097/CNJ.0000000000000823.
14. Zoromski LM, Frazier S. Nurses' role in promoting medication adherence. *Nursing*. 2023;53(1):39-44. doi:10.1097/01.NURSE.0000902956.76232.93.
15. Ozaras G, Abaan S. Investigation of the trust status of the nurse-patient relationship. *Nurs Ethics*. 2018;25(5):628-639. doi:10.1177/0969733016664971.
16. Sedighi S, Sadeghi A, Roshanaei G, Purfarzad Z. The relationship between nurses' caring behaviors and patient loyalty: Trust towards nurses as a mediating role. *BMC Nurs*. 2025;24(1):568. doi:10.1186/s12912-025-03207-5.
17. Deniz S, Akbolat M, Çimen M, Ünal Ö. The mediating role of shared decision-making in the effect of the patient-physician relationship on compliance with treatment. *J Patient Exp*. 2021;8:23743735211018066. doi:10.1177/23743735211018066.
18. Slyer JT. Shared decision-making to improve medication adherence. *Nurse Pract*. 2022;47(8):41-47. doi:10.1097/01.NPR.0000841928.60278.75.
19. Bahari Z, Vosoghi N, Ramazanzadeh N, Moshfeghi S, Aghamohammadi M. Patient trust in nurses: Exploring the relationship with care quality and communication skills in emergency departments. *BMC Nurs*. 2024;23:595. doi:10.1186/s12912-024-02241-z.
20. Li Y, Chen W, Hong Y, Hong J, Chen H. Impact of an orthopedic nurse specialist-led therapeutic communication model on medication adherence in patients with fragility fractures. *Am J Nurs Sci*. 2025;14(2):22-29. doi:10.11648/j.ajns.20251402.11.
21. Rehman A, Naz Z, Ali A, Naz F, Tabassum Siddique F. Meta-analysis of nurse-led interventions on medication adherence and clinical outcomes in patients with chronic illnesses. *Insights J Health Rehabil*. 2025;3(6):38-47. doi: [10.71000/w46qv993](https://doi.org/10.71000/w46qv993).
22. Abel WM, Efrid JT. The association between trust in health care providers and medication adherence among Black women with hypertension. *Front Public Health*. 2013;1:66. doi:10.3389/fpubh.2013.00066.

23. Aliafsari Mamaghani E, Soleimani A, Zirak M. Trust in nurses and its association with medication adherence of cardiovascular patients. *Int J Nurs Stud Adv*. 2024;8:100278. doi:10.1016/j.ijnsa.2024.100278.
24. Alosaimi K, Alwafi H, Alhindi Y, et al. Medication adherence among patients with chronic diseases in Saudi Arabia. *Int J Environ Res Public Health*. 2022;19(16):10053. doi:10.3390/ijerph191610053.
25. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
26. İspir Demir Ö, Yıldırım A, Sönmez B, Duygulu S. Relationship between structural empowerment and nurse- and patient-reported outcomes: The mediating role of control over nursing practices. *West J Nurs Res*. 2023;45(7):634-645. doi:10.1177/01939459231169146.
27. Yakar B, Demir M. Kronik böbrek yetmezliği olan hastalarda antihipertansif ilaç tedavisine uyum oranları ve etkileyen faktörlerin araştırılması. *Dicle Med J*. 2019;46(4):685-696. doi: [10.5798/dicletip.661259](https://doi.org/10.5798/dicletip.661259).
28. Radwin EL, Cabral JH. Trust in nurses scale: Construct validity and internal reliability evaluation. *J Adv Nurs*. 2010;66(3):683-689. doi: 10.1111/j.1365-2648.2009.05168.x.
29. Çınar Yucel S, Ay S. Reliability and validity of a Turkish version of the Trust in Nurses Scale. *Soc Behav Pers*. 2013;41(10):1737-1745. doi: [10.2224/sbp.2013.41.10.1737](https://doi.org/10.2224/sbp.2013.41.10.1737).
30. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care*. 1986;24(1):67-74. doi: 10.1097/00005650-198601000-00007.
31. Vural B, Acar ÖT, Topsever P, Filiz TM. Modifiye Morisky ölçeğinin Türkçe geçerlilik güvenilirlik çalışması. *Turk J Fam Pract*. 2012;3(4):17-20.
32. Gömleksiz M, Gömleksiz MR, Gelen Ş, Uzala ES, Yakar B. Effectiveness of a knowledge level of hypertension on blood pressure control, treatment adherence, and physical activity of hypertensive individuals. *J Clin Hypertens (Greenwich)*. 2025;27(1):e14958. doi:10.1111/jch.14958.
33. Taylor LA, Nong P, Platt J. Fifty years of trust research in health care: A synthetic review. *Milbank Q*. 2023;101(1):126-178. doi: 10.1111/1468-0009.12598.
34. Kamimura A, Higham R, Rath N, Panahi S, Lee E, Ashby J. Patient-Provider relationships among vulnerable patients: The association with health literacy, continuity of care, and self-rated health. *J Patient Exp*. 2020 Dec;7(6):1450-1457. doi: 10.1177/2374373519895680.

- 35.** Darby M, Smith L, Waldron B, Fiandt K. Intensive primary care nursing: Exploring the impact of a nurse-led model for medically and social complex patients. *Clin Nurs Res*. 2024 Jun;33(5):384-394. doi: 10.1177/10547738241253654.
- 36.** Lu J, Li Y, Cao L, Zhou Z. Can digital finance mitigate trust issues for chronically ill patients because of relative deprivation of income? *Digit Health*. 2023 Sep 3;9:20552076231197327. doi: 10.1177/20552076231197327.
- 37.** Sheehan R, Fealy G. Trust in the nurse: Findings from a survey of hospitalised children. *J Clin Nurs*. 2020;29(21-22):4289-4299. doi:10.1111/jocn.15466.
- 38.** Berardinelli D, Conti A, Hasnaoui A, et al. Nurse-led interventions for improving medication adherence in chronic diseases: A systematic review. *Healthcare (Basel)*. 2024;12(23):2337. doi:10.3390/healthcare12232337.
- 39.** Barbuiani G, Terzoni S, Caruso R, et al. Nurses' role in deprescribing for older adults: A scoping review. *Int J Nurs Stud*. 2026;174:105274. doi:10.1016/j.ijnurstu.2025.105274.
- 40.** Smits MAA, Mammatas LH, Schoonhoven L, et al. Improving medication adherence to endocrine therapy in breast cancer patients: A mixed-methods systematic review. *Breast*. 2025;82:104510. doi:10.1016/j.breast.2025.104510.

The Role of Socio-Demographic Characteristics in Physicians' Attitudes Towards Artificial Intelligence

Erhan BIYIK*

Abstract

Aim: This study aims to determine the role of demographic characteristics in physicians' attitudes toward the general applications of artificial intelligence (AI) and their attitudes toward the applications of AI in medicine.

Method: The descriptive, cross-sectional, and quantitative study consists of data collected from 265 physicians working at a tertiary education and research hospital using stratified sampling. The data collection tools included demographic characteristics, a general AI attitude scale, and an attitude scale toward AI applications in medicine.

Results: The findings show that physicians generally have a positive attitude toward AI, but male physicians have a more positive attitude than female physicians. Negative attitudes were found to be higher among physicians working in surgical clinics. Furthermore, demographic characteristics such as gender, clinic, and title were found to be significantly associated with physicians' attitudes toward the general application of AI, while gender and department worked in had a significant association with attitudes toward the application of AI in medicine.

Conclusion: Physicians' attitudes toward AI were found to differ according to demographic factors. In light of these findings, it is recommended that targeted education programs and policies be developed to increase physicians' knowledge levels for a more effective integration of AI into the field of medicine. Strategies to raise awareness and address knowledge gaps and concerns are particularly important for female physicians and physicians working in surgical clinics.

Keywords: Artificial intelligence, artificial intelligence in medicine, physician attitude.

Hekimlerin Yapay Zekaya Karşı Tutumlarında Demografik Özelliklerin Rolü

Öz

Amaç: Bu çalışma, hekimlerin yapay zekânın (YZ) genel uygulamalarına yönelik tutumları ile YZ'nin tıptaki uygulamalarına yönelik tutumlarında demografik özelliklerin rolünü belirlemeyi amaçlamaktadır.

Yöntem: Betimleyici, kesitsel ve nicel yaklaşımla yapılan araştırma, üçüncü basamak bir eğitim ve araştırma hastanesinde görevli 265 hekimden tabakalı örneklem yöntemiyle toplanan verilerden

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 26.01.2026 **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1870403>

* (Corresponding Author) Dr., University of Health Sciences, Gülhane Training and Research Hospital, Ankara, Türkiye.

E-mail: erhanbiyik@gmail.com **ORCID** <https://orcid.org/0000-0002-3667-8847>

ETHICAL STATEMENT: Ethics committee permission for this study was obtained from the Gülhane Education and Research Hospital Education Planning Board and Ethics Committee (Date: 14.11.2024, Issue no: 2024/69).

oluşmaktadır. Veri toplama aracı olarak demografik özellikler, genel YZ tutum ölçeği ve tıpta YZ uygulamalarına yönelik tutum ölçeği kullanılmıştır.

Bulgular: Bulgular, hekimlerin YZ'ye karşı genel olarak olumlu bir tutum sergilediğini göstermekle birlikte, erkek hekimlerin kadın hekimlere göre daha olumlu tutuma sahip olduğunu ortaya koymuştur. Olumsuz tutumlar ise cerrahi klinikte çalışan hekimlerde daha yüksek bulunmuştur. Ayrıca demografik özelliklerden cinsiyet, çalışılan klinik ve unvanın, hekimlerin YZ'nin genel uygulamalarına yönelik tutumları üzerinde, cinsiyet ve çalışılan kliniğin ise YZ'nin tıptaki uygulamalarına yönelik tutumları üzerinde anlamlı bir etkiye sahip olduğunu göstermektedir.

Sonuç: Hekimlerin YZ'ye yönelik tutumlarının demografik faktörlere göre farklılaştığı tespit edilmiştir. Bu bulgular ışığında, YZ'nin tıp alanına daha etkili entegrasyonu için hekimlerin bilgi düzeylerini artırmaya yönelik hedeflenmiş eğitim programlarının ve politikaların geliştirilmesi önerilmektedir. Özellikle kadın hekimler ve cerrahi klinik bölümlerde çalışan hekimler için farkındalık, bilgi eksikliklerini ve endişelerini giderecek stratejiler önem taşımaktadır.

Anahtar Sözcükler: Yapay zeka, tıpta yapay zeka, hekim tutumu.

Introduction

According to a general definition, artificial intelligence (AI) is a discipline that aims to do everything that human intelligence does, and even more, by using computer technologies¹. Software and algorithms designed to mimic human intelligence are being developed with AI. This technology finds application in various sectors, including medicine. With the emergence of advanced computing capabilities and cloud-based data systems, especially those related to machine learning and deep learning, innovative applications of AI in clinical medicine and medical research are increasingly growing². Today, artificial intelligence is used in many medical fields such as diabetes management, cancer detection and treatment, cardiological evaluations, mental health interventions, and radiological image analysis, and the identification of skin lesions³. On the other hand, AI also facilitates the routine administrative tasks of healthcare professionals. Furthermore, the use of AI offers a potential solution to important healthcare problems such as reducing diagnostic errors, medication treatments, and surgical procedures, optimizing resource utilization, and improving workflows⁴.

The literature suggests that physicians generally have a “cautious optimism” toward AI. A systematic review revealed that more than 60% of physicians and medical students have a positive approach to AI, and more than 70% are willing to use this technology in clinical practice⁵. Similarly, a qualitative study conducted in Germany confirmed that the majority of physicians are open to using AI under certain conditions⁶. A study conducted in Turkey also shows that physicians positively view the potential of AI to improve health outcomes⁷.

This general positive attitude brings with it a number of important concerns and barriers. At the forefront of these barriers are issues of trust and transparency. The fact that AI algorithms operate like a “black box,” meaning they cannot provide a clear explanation of how they arrive at their decisions, leads to distrust among physicians⁸. Physicians, due

to the principles of evidence-based medicine, need to understand the scientific and clinical rationale behind a recommendation. Indeed, a study conducted in Turkey stated that only 8.3% of physicians fully trust an autonomous AI system⁷. This supports the widespread view that the results produced by AI must be verified by a human physician^{5,6}. Furthermore, concerns about physicians' professional practices constitute a significant barrier. Fears such as the loss of professional autonomy, difficulties in integration into clinical workflows, and the reduction of human contact with the patient are the main factors limiting the acceptance of AI and influencing attitudes^{6,9}. On the other hand, errors can also be human-induced. This is because personal health data is recorded, collected, classified, and categorized by humans. Humans can make mistakes during these stages. Therefore, the correct implementation of these stages is vital. Furthermore, in case of a security issue in the system, personal health records can be deleted, stolen, or altered. This can lead to erroneous applications of AI. Therefore, considering the highly sensitive nature of health data, the use of AI should be evaluated differently from other fields, and greater importance should be given to data privacy and ethical issues¹⁰.

The successful integration of AI into healthcare requires a comprehensive understanding of physicians' knowledge and attitudes toward this new technology. Furthermore, it is important for these physicians to adopt and use these applications to increase the quality and efficiency of healthcare services. The purpose of this research is to determine the role of demographic characteristics in physicians' attitudes toward the general applications of AI and their attitudes toward the applications of AI in medicine. It is expected that the research findings will lead to the development of targeted education programs and policies, address existing gaps, and result in a more effective implementation of AI in the field of medicine. The following hypotheses were formulated with this research:

H1: Physicians' demographic characteristics (a. age, b. professional experience, c. gender, d. title, e. department worked in) are significantly associated with their negative attitudes toward AI.

H2: Physicians' demographic characteristics (a. age, b. professional experience, c. gender, d. title, e. department worked in) are significantly associated with their positive attitudes toward AI.

H3: Physicians' demographic characteristics (a. age, b. professional experience, c. gender, d. title, e. department worked in) are significantly associated with their attitudes toward AI applications in medicine.

Material and Methods

Population and Sample

The research was planned with a descriptive, cross-sectional, and quantitative approach. The population of the research consists of physicians working at a tertiary education and research hospital. For the research conducted between February 03, 2025, and May 30,

2025, a stratified sampling method was used to select the sample from the population. Physicians were divided into two strata: resident physicians and specialists. It is known that there are approximately 700 physicians in the hospital (specialists: 260, resident physicians: 440). The minimum sample size was calculated to be at least 248 with a 95% confidence interval and a 0.05 sampling error. In this case, the goal was to reach at least 93 specialists and 155 resident physicians. Considering erroneous and missing data in the face-to-face survey, the survey was terminated when a total of 265 physicians were reached. Physicians who were on leave, assignment, rest, or did not want to participate in the survey were not included in the study. Written informed consent was obtained from participants prior to the study.

Data Collection Tool

In this context, a total of 5 questions were first asked regarding the demographic characteristics of physicians, including age, gender, title, professional experience, and the department they work in. Subsequently, a scale developed by Schepman and Rodway¹¹ and adapted into Turkish by Kaya et al.¹², consisting of two dimensions (12 positive and 8 negative) and a total of 20 questions, was used to measure physicians' general attitudes toward AI. Finally, a scale developed by Oh et al.¹³ to measure physicians' attitudes toward AI in medicine, consisting of a total of 5 questions, was adapted into Turkish and used in this study. The scales were of the 5-point Likert type, with response options ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Data Analysis

Data were analyzed using the SPSS 23 statistical package programs. Exploratory factor analysis was used for the validity of the scales used in the research, and Cronbach's Alpha was used for reliability analysis. First, frequency distributions and descriptive statistics regarding the demographic characteristics of the physicians were given, and then, whether the physicians' attitudes toward AI differed according to demographic characteristics was examined with variance analysis. Finally, the research hypotheses were tested with stepwise multiple regression analysis. Since the data showed a normal distribution as a result of the examination of central tendency and dispersion measures and histogram graphs before the tests, analyses were performed with parametric statistical tests.

For regression analysis, categorical variables were coded as 0-1 and dummy variables were created in the number of one less than the number of categories of the relevant variable to prevent multicollinearity and were included in the model. For easy comparison of the created dummy variables, the category with the larger sample size was accepted as the reference. Accordingly, female in the gender variable, assistant doctor in the title variable, and internal medicine clinic in the department worked in variable were accepted as the reference. Analysis was performed as stepwise multiple regression analysis using the forward method. With this method, it was aimed to automatically select the most significant variables among the independent variables and those contributing most to the model and include them in the analysis.

Results

Participants' Demographic Characteristics

When examining the data on the demographic characteristics of physicians presented in Table 1, 50.6% of participants were female, 49.4% were male, 60.4% were resident physicians, and 39.6% were specialists. Furthermore, 31.7% of the physicians work in surgical clinics, 39.2% in internal medicine clinics, and 29.1% outside the clinic. The average age of the physicians was 34.14, and the average professional experience was 8.9 years.

Table 1. Frequency of Demographic Characteristics.

Demographic Characteristics	n	Percentage (%)
Gender		
Male	131	49.4
Female	134	50.6
Total	265	100.0
Title		
Resident physician	160	60.4
Specialist	105	39.6
Total	265	100.0
Department Worked In		
Surgical Clinic	84	31.7
Internal Medicine Clinic	104	39.2
Outside Clinic	77	29.1
Total	265	100.0
Average Age	34.14±8.91	(Min:24-Max:64)
Average professional experience	8.92±9.08	(Min:2-Max:36)

Validity and Reliability of the Scale

In the explanatory factor analysis performed for the construct validity of the general AI attitude scale of physicians, the factor analysis result showed that the total explained variance ratio of the factors constituting the scale was found to be 45.91% after fixing the number of factors to 2, considering the number of factors in the originally developed scale, and rotating with the varimax method. The factor loadings of the statements grouped under 2 dimensions as positive and negative attitudes ranged between 0.46 and 0.81, and all statements were grouped under the same dimension they belonged to in the original scale. The Attitude Scale toward AI Applications in Medicine has a single-factor structure, and the factor loadings range between 0.51 and 0.89. When the values are examined, it can be said that both scales are sufficient in terms of validity and reliability.

Table 2. Reliability, Validity and Descriptive Statistics.

Statements	$\bar{X}$	SD	Factor Loadings	Explained Variance	Cronbach's Alpha
General Positive Attitudes	3.81	0.62		31.43%	0.86
1. I am interested in using artificial intelligence systems in my daily life.	3.88	0.97	0.73		
2. Artificial intelligence has many beneficial applications.	4.23	0.79	0.63		
3. Artificial intelligence is exciting.	4.16	0.82	0.62		
4. Artificial intelligence can provide new economic opportunities for this country.	4.22	0.86	0.61		
5. I would like to use artificial intelligence in my own work.	3.95	1.07	0.61		
6. A software/robot with artificial intelligence can do many routine tasks better than a human.	3.54	1.01	0.59		
7. I am impressed by what artificial intelligence can do.	4.25	0.73	0.81		
8. Artificial intelligence can have positive effects on people's well-being.	3.52	1.03	0.58		
9. Artificial intelligence systems can help people feel happier.	3.38	1.01	0.50		
10. Artificial intelligence systems can perform better than humans.	3.60	1.02	0.65		
11. Most of society will benefit from a future equipped with artificial intelligence.	3.94	1.00	0.65		

12. For routine tasks, I would prefer to interact with an artificial intelligence system rather than a human.	3.12	1.24	0.65		
General Negative Attitudes	2.85	0.69		14.48%	0.82
13. I think artificial intelligence is dangerous.	3.34	1.04	0.71		
14. Organizations use artificial intelligence in an unethical way.	3.68	0.97	0.63		
15. I find artificial intelligence to be evil/malicious.	2.42	1.07	0.76		
16. Artificial intelligence is used to monitor people.	3.26	1.17	0.71		
17. I tremble with sadness when I think about the future uses of artificial intelligence.	1.98	1.03	0.54		
18. Artificial intelligence can take control of people.	2.61	1.16	0.68		
19. I think artificial intelligence systems make many mistakes.	3.14	0.92	0.47		
20. I think people like me will be harmed if artificial intelligence is used more and more.	2.43	0.98	0.60		
Attitude Scale toward AI Applications in Medicine	2.76	0.60		41.07%	0.61
1. Do you agree that you have good knowledge about artificial intelligence?	2.78	1.11	0.585		
2. Do you agree that artificial intelligence has beneficial applications in the field of medicine?	4.07	0.61	0.894		
3. Do you agree that the diagnostic ability of artificial intelligence is superior to the clinical experience of physicians?	2.07	0.83	0.860		
4. Do you agree that artificial intelligence can replace your job?	2.15	0.98	0.676		
5. Do you agree that you will always use artificial intelligence when making medical decisions in the future?	2.78	1.17	0.514		

Findings Regarding Attitudes Toward AI Applications

The results of the analysis regarding physicians' negative attitudes toward general AI applications are presented in Table 3. Physicians' negative attitudes differ according to the department studied ($p < 0.05$). When the subgroups are examined, the difference is seen between physicians working in internal medicine clinics ($\bar{x}: 2.82$) and surgical clinics ($\bar{x}: 3.11$), and between physicians working in surgical clinics and outside the clinic ($\bar{x}: 2.62$). On the other hand, physicians' negative attitudes do not show a significant difference according to gender and title ($p > 0.05$).

According to the findings presented in Table 3, which shows the results of the analysis of positive attitudes, physicians' positive attitudes differ according to their gender ($p < 0.05$). The average of male physicians ($\bar{x}: 3.93$) is higher than the average of female physicians ($\bar{x}: 3.70$). On the other hand, physicians' positive attitudes do not show a significant difference according to title and department worked in ($p > 0.05$).

According to the analysis results presented in Table 3 regarding physicians' attitudes towards AI applications in medicine, physicians' attitudes differ according to gender and department ($p < 0.05$). The average of male physicians ($\bar{x}: 2.90$) is higher than the average of female physicians ($\bar{x}: 2.68$). According to the department worked in, physicians working in surgical clinics ($\bar{x}: 2.59$) have a lower attitude than physicians working in internal medicine clinics ($\bar{x}: 2.84$) and outside the clinic ($\bar{x}: 2.86$).

Table 3. Differentiation of Attitudes toward AI Applications According to Demographic Characteristics

	Variables		n	$\bar{x}$	SD	t/F	p	Difference
General Negative Attitudes	Gender	Female	134	2.84	0.66	-0.31	>0.05	-
		Male	131	2.87	0.73			
	Title	Resident	160	2.86	0.65	0.37	>0.05	-
		physician Specialist	105	2.83	0.75			
	Department Worked In	a. Surgical	84	3.11	0.70	10.91	<0.05	a-b b-c
		Clinic	104	2.82	0.70			
		b. Internal	77	2.62	0.56			
		Clinic c. Outside Clinic						
General Positive Attitudes	Gender	Female	134	3.70	0.63	-3.149	<0.05	+
		Male	131	3.93	0.58			
	Title	Resident	160	3.83	0.46	0.42	>0.05	-
		physician Specialist	105	3.79	0.80			
	Department Worked In	a. Surgical	84	3.89	0.45	1.51	>0.05	-
		Clinic	104	3.75	0.78			
		b. Internal	77	3.77	0.60			
		Clinic c.Outside Clinic						
Attitudes toward AI Applications in Medicine	Gender	Female	134	2.63	0.50	-3.69	<0.05	+
		Male	131	2.90	0.66			
	Title	Resident	160	2.72	0.58	-1.49	>0.05	-
		physician Specialist	105	2.83	0.62			
	Department Worked In	a. Surgical	84	2.74	0.58	7.80	<0.05	a-c b-c
		Clinic	104	2.60	0.69			
		b. Internal	77	2.97	0.44			
		Clinic c. Outside Clinic						

Demographic Characteristics Associated with Physicians' Negative Attitudes Toward General Applications of Artificial Intelligence

In the regression analysis conducted to analyze how physicians' demographic characteristics predict their attitudes toward AI applications, the impact on negative attitudes was first analyzed. According to the results presented in Table 4, the most significant model was reached in the third stage of the multiple regression analysis that occurred in three stages.

According to the analysis results, the department worked in, professional experience, and title were found to be variables are statistically significantly associated with physicians' negative attitudes toward AI usage. It was determined that these three variables explained approximately 12% of the total variance and that the model was statistically significant ($F:11.612$; $p<0.05$). When compared with physicians working in internal medicine clinics, physicians working in surgical clinics have higher probabilities of displaying negative attitudes, and when compared with resident physicians, specialist physicians have higher probabilities of displaying negative attitudes. In other words, working in a surgical clinic and being a specialist physician are positively associated with negative attitudes. On the other hand, physicians with longer professional experience have higher probabilities of displaying negative attitudes. In this case, hypotheses H1b, H1d, and H1e were accepted, while hypotheses H1a and H1c were rejected.

Demographic Characteristics Determining Physicians' Positive Attitudes Toward General Applications of Artificial Intelligence

Second, the impact on positive attitudes was analyzed, and the most significant model was reached in the third stage of the multiple regression analysis that occurred in three stages.

According to the analysis results presented in Table 4, gender, department worked in, and professional experience are variables that are statistically significantly associated with physicians' positive attitudes toward AI usage. It was determined that these three variables explained approximately 7% of the total variance and that the model was statistically significant ($F:6.908$; $p<0.05$). When compared with female physicians, male physicians have higher probabilities of displaying positive attitudes, whereas when compared with physicians working in internal medicine clinics, physicians working in surgical clinics have lower probabilities of displaying positive attitudes. In other words, being male shows a positive effect on positive attitudes, while working in a surgical clinic has a negative effect on it. On the other hand, physicians with shorter professional experiences have higher probabilities of displaying positive attitudes. That is, professional experience shows a negative effect on positive attitudes. In this case, hypotheses H2b, H2c, and H2e were accepted, while hypotheses H2a and H2d were rejected.

Demographic Characteristics Determining Physicians' Attitudes toward AI Applications in Medicine

Finally, the impact of physicians' demographic characteristics on their attitudes toward AI applications in medicine was analyzed, and the most significant model was reached in the second stage of the multiple regression analysis that occurred in two stages.

According to the analysis results presented in Table 4, gender and department worked in are variables that statistically significantly associated with physicians' attitudes toward AI applications in medicine. It was determined that these two variables explained approximately 11% of the total variance and that the model was statistically significant

($F:15.685$; $p<0.05$). When compared with female physicians, male physicians have higher probabilities of agreeing with statements regarding AI applications in medicine, whereas when compared with physicians working in internal medicine clinics, physicians working in surgical clinics have lower probabilities of agreeing. In this case, hypotheses H3c and H3e were accepted, while hypotheses H3a, H3b, and H3d were rejected.

Table 4. Regression Analysis Results Regarding the Association of Demographic Characteristics on Attitudes toward AI.

Dependent Variable	Independent Variables	B	Std. Error	β	t	p	R ²	F
General Negative Attitudes	Constant	2.859	0.065		44.305	<0.05	0.118	11.62
	Surgical clinic	0.331	0.087	0.222	3.794	<0.05		
	Internal clinic	Reference	0.026					
	Professional Experience	0.315	0.006	0.340	4.043	<0.05		
	Specialist Assistant	Reference	0.119	0.222	2.649	<0.05		
General Positive Attitudes	Constant	3.809	0.062		61.543	<0.05	0.074	6.908
	Male	0.347	0.081	0.280	4.264	<0.05		
	Female	Reference	-0.011					
	Professional Experience	-0.194	0.004	-0.168	-2.613	<0.05		
	Surgical clinic	Reference	0.083	-0.146	-2.341	<0.05		
Attitudes toward AI Applications in Medicine	Constant	2.704	0.052		51.880	<0.05	0.107	15.68
	Male	0.328	0.072	0.280	4.664	<0.05		
	Female	Reference	-0.320			<0.05		
	Surgical clinic	Reference	0.078	-0.247	-4.109	<0.05		
	Internal clinic							

Discussion

Regarding the predictive power of our statistical models, the stepwise multiple regression analysis revealed that socio-demographic characteristics explained a statistically significant but relatively modest portion of the total variance in physicians' attitudes. This level of explanatory power is frequently observed and considered acceptable in cross-sectional behavioral and organizational research within healthcare settings. It indicates that while baseline demographic variables like gender, department, and professional experience are meaningful structural anchors, a substantial proportion of the variance in AI acceptance remains driven by unmeasured, non-demographic individual factors.

This study has revealed that male physicians have significantly more positive attitudes toward AI in general and toward its applications in medicine compared to female physicians. In other words, the research findings demonstrate a significant link between gender and physicians' attitudes toward AI in general and its applications in medicine. The effect of gender on attitudes toward AI applications has been shown in the literature with varying results. According to some studies, attitudes toward AI differ according to gender¹⁴. However, a study in Bahrain found no significant relationship between gender

and attitudes¹⁵, a study conducted in China showed that gender significantly influenced attitudes⁵. A study conducted in the UK also indicated that AI usage is higher among young and male doctors⁸. The study by Ahmed et. al.³ stated that men are 0.67 times more likely than women to have positive attitudes toward AI. These studies show that gender, along with cultural and social factors, may play a role in technology adaptation processes.

When age and experience factors were examined in this study, no significant association of age and experience was identified with generally negative attitudes toward AI and its applications in medicine, while no effect of age was found on positive attitudes, but an effect of length of practice (experience) was detected. This shows that physicians with less work experience may have positive attitudes. In the literature, age and experience factors stand out as the factors with the most variable effect on attitudes towards AI. Some comprehensive studies, like this one, have found that age does not have a direct effect on attitudes. For example, a study conducted in Bahrain also found no correlation between age, years of experience, and attitudes¹⁵. A large-scale study of 3,666 radiology assistants in China showed that younger assistants had more positive attitudes toward AI¹⁶.

In this study, while a title was found to have an effect on negative attitudes toward AI, no effect of title was detected on positive attitudes or attitudes toward AI applications in medicine. Specialist physicians may generally exhibit negative attitudes toward AI applications. Contrary to this study, a study conducted in Saudi Arabia found that the field of specialization was the strongest determinant of trust in AI and that specialist physicians were four times more likely to trust AI than general practitioners¹⁷.

This study also found that attitudes toward AI showed significant differences depending on the department studied. Physicians working in surgical clinics, in particular, may have negative attitudes toward both general AI and its applications in medicine. Alrashed et al.¹⁷ found similar results in their study. This pronounced caution among surgical specialists may be deeply rooted in the unique operational environment of surgical clinics. Unlike diagnostic or administrative tasks where AI serves as a passive support system, autonomous or semi-autonomous AI applications in surgery (such as robotic-assisted devices or intraoperative decision tools) directly intersect with the surgeon's immediate accountability and manual autonomy. Therefore, the higher negative attitudes observed in this subgroup likely reflect a proactive concern over patient safety, liability frameworks, and the preservation of critical manual decision-making control rather than a mere resistance to technological innovation. In contrast, the fact that non-clinical physicians have the most positive attitude toward AI applications in medicine can be explained by this group viewing artificial intelligence more as a tool that facilitates administrative and supportive tasks.

In the literature, the speciality studied also stands out as the variable that most strongly and consistently influences attitudes toward AI among demographic factors. A study in Bahrain indicated that pathologists were the group most positive about AI use in specific tasks, such as creating personalized treatment plans¹⁵. Another global survey among

pathologists revealed a high level of acceptance of AI¹⁸. The fact that current AI applications largely focus on image analysis and data interpretation may be cited as a reason for this differentiation in the field of expertise studied. This situation, on the other hand, makes specialists such as radiologists and pathologists both the greatest potential beneficiaries of the technology and the groups most concerned about their professional future. Indeed, according to studies conducted in China and Japan, while the vast majority of radiologists believe they should embrace AI, they are also concerned that this technology will reduce the demand for radiologists in the future^{16,19}.

Limitations of the Research

This study was limited to physicians because they are active users of AI in medicine. Although sufficient time was allocated for the survey, the busy work pace of physicians may have limited participation in the surveys. Furthermore, whether physicians have knowledge about artificial intelligence or not does not prevent them from participating in the research. Some physicians may not have knowledge about artificial intelligence. In this research, it was assumed that physicians had some level of knowledge about artificial intelligence, and their knowledge levels were not measured. This situation can be considered a limiting factor for the research results. On the other hand, since this study was conducted in a single tertiary hospital, the findings may not be generalizable to primary or secondary healthcare facilities, private practices, or regions with diverse clinical resources.

Additionally, a notable limitation of this study is the relatively modest internal consistency demonstrated by the 'Attitude Scale toward AI Applications in Medicine'. While this value satisfies the minimum acceptable threshold frequently cited for exploratory social and behavioral research, it warrants cautious interpretation. The lower reliability coefficient may be attributed to the brief structure of the scale and the broad conceptual scope of the questions, which range from self-reported clinical knowledge to profound career displacement anxieties. Consequently, future studies focusing on physicians' digital health integration should consider expanding or refining this specific tool to capture domain-specific medical AI attitudes with enhanced internal reliability.

Conclusion

Ultimately, physicians' attitudes toward AI use in medicine reflect a mix of interest in the technology's potential benefits and legitimate concerns about practical, ethical, and professional challenges. The successful widespread adoption of AI in healthcare depends not only on technological advances but also on the development of transparent, reliable, and user-friendly systems that will gain physicians' trust, the clarification of legal and ethical frameworks, and, most importantly, the implementation of comprehensive training strategies that will ensure physicians' active participation in this transformation process.

To alleviate physicians' concerns, AI algorithms should be developed with interpretable interfaces that explain their decision-making processes, and physicians should be able to understand the logic behind the diagnosis or treatment decisions suggested by AI. AI applications should be easily integrated into and personalized for different clinical workflows (Internal Medicine, Surgery, Outpatient). To overcome the more negative attitude, especially in surgical clinics, tools with high practical benefits specific to these areas should be designed. Considering that female physicians have a lower average positive attitude, features that are more suitable for the needs and working styles of female physicians, with high ease of use and supporting clinical decision-making processes, should be prioritized. The creation of internal policies and guidelines that clarify data privacy, ethical responsibility, and the legal framework regarding AI use will contribute to countering the negative attitudes of surgeons in particular.

REFERENCES

1. Keleş H. Tıpta yapay zeka uygulamaları. *Kırıkkale Üniversitesi Tıp Fakültesi Dergisi*. 2022;24(3):604-613. doi:10.24938/kutfd.1214512.
2. Liu DS, Sawyer J, Luna A, et al. Perceptions of us medical students on artificial intelligence in medicine: Mixed methods survey study. *JMIR Med Educ*. 2022;8(4). doi:10.2196/38325.
3. Ahmed MM, Dirie NI, Mohamud AK, et al. Assessment of knowledge, attitudes, and practices in artificial intelligence among healthcare professionals in Mogadishu, Somalia. *Research Square*. Preprint posted online May 14, 2024. doi:10.21203/rs.3.rs-4359643/v1.
4. Pedro AR, Dias MB, Laranjo L, Cunha AS, Cordeiro J V. Artificial intelligence in medicine: A comprehensive survey of medical doctor's perspectives in Portugal. *PLoS One*. 2023;18(9 September). doi:10.1371/journal.pone.0290613.
5. Chen M, Zhang B, Cai Z, et al. Acceptance of clinical artificial intelligence among physicians and medical students: A systematic review with cross-sectional survey. *Front Med (Lausanne)*. 2022;9. doi:10.3389/fmed.2022.990604.
6. Negash S, Gundlack J, Buch C, et al. Physicians' attitudes and acceptance towards artificial intelligence in medical care: A qualitative study in Germany. *Front Digit Health*. 2025;7. doi:10.3389/fdgh.2025.1616827.
7. Serin O, Yıldırım BF, Duman F, et al. Physician perspectives on Artificial Intelligence in healthcare: A cross-sectional study of child-focused care in a Turkish tertiary hospital. *Int J Med Inform*. 2025;203. doi:10.1016/j.ijmedinf.2025.106003.

8. Hassan M, Kushniruk A, Borycki E. Barriers to and facilitators of artificial intelligence adoption in health care: Scoping review. *JMIR Hum Factors. JMIR Publications Inc.* 2024;11. doi:10.2196/48633.
9. Lambert SI, Madi M, Sopka S, et al. An integrative review on the acceptance of artificial intelligence among healthcare professionals in hospitals. *NPJ Digit Med. Nature Research.* 2023;6(1). doi:10.1038/s41746-023-00852-5.
10. Başar EE, Kes Erkul A. Factors affecting the attitude of medical doctors in Türkiye towards using artificial intelligence applications in healthcare services. *Bezmialem Science.* Published online July 31, 2024:297-308. doi:10.14235/bas.galenos.2024.26879.
11. Schepman A, Rodway P. The general attitudes towards Artificial Intelligence Scale (gaais): Confirmatory validation and associations with personality, corporate distrust, and general trust. *Int J Hum Comput Interact.* 2023;39(13):2724-2741. doi:10.1080/10447318.2022.2085400.
12. Kaya F, Aydin F, Schepman A, Rodway P, Yetişensoy O, Demir Kaya M. The roles of personality traits, AI anxiety, and demographic factors in attitudes toward artificial intelligence. *Int J Hum Comput Interact.* 2024;40(2):497-514. doi:10.1080/10447318.2022.2151730.
13. Oh S, Kim JH, Choi SW, Lee HJ, Hong J, Kwon SH. Physician confidence in artificial intelligence: An online mobile survey. *J Med Internet Res.* 2019;21(3). doi:10.2196/12422.
14. Kovacevic A, Demic E. The impact of gender, seniority, knowledge, and interest on attitudes to artificial intelligence. *IEEE Access.* 2024;12:129765-129775. doi:10.1109/ACCESS.2024.3454801.
15. Al-Medfa MK, Al-Ansari AMS, Darwish AH, Qreeballa TA, Jahrami H. Physicians' attitudes and knowledge toward artificial intelligence in medicine: Benefits and drawbacks. *Heliyon.* 2023;9(4). doi:10.1016/j.heliyon.2023.e14744.
16. Chen Y, Wu Z, Wang P, et al. Radiology Residents' Perceptions of artificial intelligence: Nationwide cross-sectional survey study. *J Med Internet Res.* 2023;25(1). doi:10.2196/48249.
17. Alrashed FA, Ahmad T, Alsabih AO, Mahmoud S, Almurdi MM, Abdulghani HM. Exploring medical doctors' confidence in artificial intelligence: The role of specialty, experience, and perceived job security. *Healthcare (Switzerland).* 2025;13(18). doi:10.3390/healthcare13182377.
18. Sarwar S, Dent A, Faust K, et al. Physician perspectives on integration of artificial intelligence into diagnostic pathology. *NPJ Digit Med.* 2019;2(1). doi:10.1038/s41746-019-0106-0.

19. Coppola F, Faggioni L, Regge D, et al. Artificial intelligence: Radiologists' expectations and opinions gleaned from a nationwide online survey. *Radiologia Medica*. 2021;126(1):63-71. doi:10.1007/s11547-020-01205-y.

Artificial Intelligence Addiction, Technostress, and Work-Life Balance Among Academics: An Employee Health Perspective

Raife AŞIK*, Nida EFETÜRK**, Fatoş TOZAK***

Abstract

Aim: This study aims to examine the relationships between artificial intelligence addiction tendencies, technostress levels, and work-life balance among academics within the framework employee health.

Method: This study was designed using a correlational survey model within the framework of quantitative research methods. The population of the study consisted of academics working at universities in Türkiye. Data were collected using a sociodemographic information form, the Artificial Intelligence Addiction Scale, the Technostress Scale, and the Work-Life Balance Scale. Statistical analyses were performed using SPSS for Windows 25.0 software.

Results: The findings indicated that the levels of artificial intelligence addiction (11.12 ± 4.17) and technostress (56.13 ± 12.85) among the participating academics ($n=450$) were moderate, with techno-overload identified as the most prominent subdimension of technostress. The analyses revealed positive and statistically significant correlations among the variables ($p < 0.01$). Regression analysis demonstrated that both artificial intelligence addiction and technostress significantly and positively predicted work-life balance ($R^2 = 0.315$). From a sociodemographic perspective, younger academics (research assistants) exhibited higher levels of artificial intelligence addiction and work-life balance compared to professors. Additionally, a heavy teaching load of 16 hours or more per week was found to significantly increase the technostress level.

Conclusion: Artificial intelligence addiction and technostress are thought to be viewed not as destabilizing risk factors for academics but rather as a “functional adaptation tool” used to manage academic workload. While this resulting “good stress state” positively supports work-life balance, implementing human-centered digital policies at the corporate level is necessary to prevent long-term cognitive fatigue.

Keywords: Academics, artificial intelligence addiction, technostress, work-life balance.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 24.03.2026 **Kabul / Accepted:** 09.08.2026

DOI: <https://doi.org/10.38079/igusabder.1914738>

* Asst. Prof., Dr., Istanbul Okan University, Faculty of Health Sciences, Department of Nursing, Istanbul, Türkiye.

E-mail: raife.asik@okan.edu.tr [ORCID](https://orcid.org/0000-0002-6023-8649) <https://orcid.org/0000-0002-6023-8649>

** Asst. Prof., Dr., Kocaeli University of Health and Technology, Department of Nursing, Department of Nursing, Kocaeli, Türkiye. E-mail: nida.efeturk@kocaelisaglik.edu.tr [ORCID](https://orcid.org/0000-0001-8322-8200) <https://orcid.org/0000-0001-8322-8200>

*** Asst. Prof., Dr., Istanbul Okan University, School of Health Services, First Aid and Emergency Care Programme, Istanbul, Türkiye. E-mail: fatos.tozak@okan.edu.tr [ORCID](https://orcid.org/0000-0002-9509-6062) <https://orcid.org/0000-0002-9509-6062>

ETHICAL STATEMENT: This study was conducted following approval No. 199 dated 04/03/2026 from the Ethics Committee of Istanbul Okan University. Informed consent forms were obtained from all participants in accordance with the Declaration of Helsinki.

Akademisyenlerde Yapay Zeka Bağımlılığı, Teknostres ve İş Yaşam Dengesi: Çalışan Sağlığı Perspektifi

Öz

Amaç: Bu çalışmanın amacı akademisyenlerde yapay zekâ kullanımına bağlı bağımlılık eğilimlerinin, teknostres düzeyi ve iş-yaşam dengesi arasındaki ilişkilerini çalışan sağlığı perspektifinden incelemektir.

Yöntem: Araştırma, nicel araştırma yöntemlerinden ilişkisel tarama modelinde tasarlanmıştır. Evrenini Türkiye'deki üniversitelerde görev yapan akademisyenlerin oluşturduğu çalışmada veriler; sosyodemografik bilgi formu, Yapay Zekâ Bağımlılığı Ölçeği, Teknostres Ölçeği ve İş-Yaşam Dengesi Ölçeği kullanılarak toplanmıştır. Veriler, SPSS for Windows 25.0 yazılımı kullanılarak analiz edilmiştir.

Bulgular: Araştırmaya katılan akademisyenlerin (n=450) yapay zekâ bağımlılığı (11,12±4,17) ve teknostres (56,13±12,85) düzeyleri orta seviyede bulunmuş olup, en baskın teknostres alt boyutu "tekno-aşırı yüklenme"dir. Analizler sonucunda, değişkenler arasında pozitif yönlü ve anlamlı ilişkiler saptanmıştır (p<0,01). Regresyon analizi sonuçları, yapay zekâ bağımlılığı ve teknostresin iş-yaşam dengesini pozitif yönde anlamlı bir biçimde yordadığını göstermiştir (R²=,315). Sosyodemografik açıdan, genç akademisyenlerin (araştırma görevlileri) yapay zekâ bağımlılığı ve iş-yaşam dengesi puanları profesörlere göre daha yüksek çıkarken, 16 saat ve üzeri yoğun ders yükünün teknostresi anlamlı düzeyde artırdığı saptanmıştır.

Sonuç: Çalışma, yapay zekâ bağımlılığı ve teknostresin akademisyenlerde dengeyi bozan risk faktörlerinden ziyade, iş yükünü yönetmek için kullanılan "fonksiyonel bir adaptasyon" aracı olduğunu göstermiştir. Elde edilen bu "iyi stres" durumu iş-yaşam dengesini pozitif yönde desteklese de uzun vadeli bilişsel yorgunlukları önlemek adına kurumsal düzeyde insan odaklı dijital politikaların hayata geçirilmesi gerekmektedir.

Anahtar Sözcükler: Akademisyen, yapay zeka bağımlılığı, teknostres, iş yaşam dengesi.

Introduction

The rapid advancement of artificial intelligence (AI) technologies, the increasing ease of access to information, and their swift integration into daily life have transformed the human–technology relationship into a new dimension. The loss of control over technology has been conceptualized in the literature as “artificial intelligence addiction”¹. This construct was operationalised by few psychometric instruments (i.e., AI Addiction Scale–21 [AIAS-21], the Research Artificial Intelligence Addiction Scale particularly designed for scientists and researchers, dependency scales derived from some classical behavioral-addiction conceptualizations like Griffiths’ components model)²⁻⁴. Recently gaining attention in the literature, AI addiction may lead to social isolation and anxiety by diminishing individuals’ problem-solving abilities, interpersonal skills, and emotional intelligence⁵. Kooli et al. (2025) suggest that addiction to generative AI may represent a novel behavioral disorder characterized by compulsive use, tolerance, and withdrawal-like discomfort when access to AI tools is restricted⁶. Moreover, intensive use of AI has been associated with concerns such as data privacy risks, digital fatigue, technostress, and job insecurity, all of which pose significant threats to mental health³. Consistent with this perspective, Zhang et al. (2024) demonstrated that academic self-efficacy, performance expectations, and academic stress are significant predictors of problematic

AI use among university students. Their findings suggest that AI dependency in educational settings is shaped not merely by exposure to AI technologies but by the combined influence of individual competencies and contextual academic pressures⁷.

In recent years, the rapid development of AI alongside digital transformation and its integration into both professional and educational environments have begun to reshape academic processes. While AI enhances academic productivity and accelerates access to information in research activities, it also facilitates the completion of routine administrative tasks—such as paperwork—in a shorter time, thereby allowing academics to allocate more time to their core responsibilities⁸. While this wave of transformation brings with it tremendous opportunities more efficiency, inclusivity, and innovation, it also puts employees, educators, and the organizations (enterprises) in various sectors under considerable stress and psychological pressure^{9,10}. The pressure of an expectation of constant connectivity facilitated by omnipresent networks, and the need to cope with the fast pace introduced by digital technologies, is a significant source of stress for academics. This is commonly referred to as technostress, which can be defined as an unwanted effect of the technological demand⁹. Building on the widely accepted framework proposed by Tarafdar et al., technostress is commonly conceptualized through five key “technostress creators”: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. Each of these dimensions represents a distinct source of stress associated with the increasing demands of information and communication technologies (ICTs). Previous research has shown that technostress can negatively affect both individual well-being and organizational outcomes¹¹. Expanding this perspective, Tarafdar, Cooper, and Stich, introduced the concept of the “technostress trifecta,” distinguishing between techno-distress, which impairs well-being and job performance, and techno-eustress, a positive, challenge-oriented response to technology that can foster engagement, motivation, and improved performance. This distinction provides an important theoretical perspective for understanding the dual nature of technostress, particularly in demanding and adaptive environments such as higher education^{12,13}.

Continuous exposure to email and message notifications throughout the day may disrupt academics’ work–life balance. Furthermore, the increasing workload driven by technology use may lead to decreased job satisfaction and increased levels of burnout¹³.

Additionally, the overload of digital tools and the uncertainty arising from insufficient technological competence may evoke feelings of threat and insecurity. Such conditions negatively affect employees’ work–life balance. Higher levels of technostress are associated with reduced job satisfaction, increased turnover intentions, and decreased productivity^{14,15}. Empirical findings from higher education further support this relationship. Truța et al. (2023) reported that academics who remained continuously connected to work through digital technologies experienced higher levels of technostress and lower psychological well-being, with these effects being particularly pronounced among faculty members facing heavier workloads¹⁶. Likewise, using structural equation modeling, Wang et al. (2023) found that work–home conflict serves as a significant

antecedent of techno-stressors, which subsequently exert a negative impact on the psychological well-being of academic staff¹⁷.

Accordingly, the relationship between technostress and work–life balance is generally negative. Despite the speed and convenience provided by technology, the blurring of boundaries between professional and personal roles makes it increasingly difficult for individuals to maintain balance¹⁰. When academics struggle to adapt to technological changes, they may experience stress, pressure, and fear of job loss^{10,18}. This pattern is not unique to senior faculty, is not unique: research on technostress among novice teachers suggests that early-career academics, understandably combining the demands of developing professional competence while meeting institutional technological expectations exhibit unique and frequently heightened stress profiles compared to their more experienced colleagues¹⁹, whereas stronger pedagogical–technological competence exists at least in theory to buffer—if not fully eliminate—these effects²⁰.

Although numerous studies in the literature have examined the effects of technology on employees' stress levels and work–life balance^{10,17,18}. Nevertheless, most of the existing evidence has been derived from studies involving university students or teachers in primary and secondary education^{7,21}. Comparatively few studies have simultaneously investigated AI addiction, technostress, and work–life balance within the same academic population or explored whether these relationships differ according to academic rank, teaching workload, and other sociodemographic characteristics of academic staff¹⁶⁻¹⁹. Given the very fast penetration of AI in academic work life, there is an urgent need to comprehensively investigate its impacts on academics' psychological well-being and work–life balance. Accordingly, the main purpose of the current research is to explore AI-related addiction tendencies and levels of technostress, as well as work–life balance among academic professionals in Turkey through an employee health perspective. More specifically, the study seeks to examine (a) the relationships among these three constructs, (b) the extent to which AI addiction and technostress predict work–life balance, and (c) whether these constructs differ according to academics' sociodemographic and occupational characteristics, including academic rank and weekly teaching workload.

We study AI use-related addiction tendencies, technostress, and work-life balance in the academic setting. AI use and technostress may not only be risk factors but also serve a positive role in some contexts as well; however, this depends on the specific scenario. This interpretation is consistent with the techno-eustress perspective, which argues that technology-related demands are not necessarily detrimental. Instead, under appropriate conditions, they may be experienced as manageable challenges that promote effective coping, enhance performance, and foster adaptation rather than acting solely as sources of strain or disruption¹².

Material and Methods

Study Design and Participants

This was the first cross-sectional study that evaluates the relationship between artificial intelligence (AI) addiction with technostress and work–life balance among academics working in public universities and foundation universities in Turkey. After approval from the institutional ethics committee, data were collected via an online survey (Google Forms) between March and April 2026.

A total of 450 academics aged 18 years and older, employed either full-time or part-time, and who provided informed consent were included in the study. Individuals working outside Turkey, those who had never used AI-supported tools, participants under the age of 18, those who completed the questionnaire incompletely or inaccurately, and those who withdrew from the study were excluded.

Data Collection Instruments

The survey consisted of four sections: The Personal Information Form, the Artificial Intelligence Addiction Scale, the Technostress Creators Scale, and the Work–Life Balance Scale.

Personal Information Form: This form, developed by the researchers, consisted of 13 items. It included questions regarding participants' age, marital status, education level, employment type, and frequency of AI use.

Artificial Intelligence Addiction Scale (AIAS): The Digital Addiction to Artificial Intelligence Scale (DAI), developed by Morales-García et al. (2024) and adapted into Turkish by Savaş (2024), was used to assess AI addiction^{21,22}. The scale is unidimensional and consists of 5 items rated on a 5-point Likert scale, yielding a total score ranging from 5 to 25. No reverse-coded items are included. In the present study, Cronbach's alpha coefficient was found to be 0.81.

Technostress Creators Scale (TCS): The Technostress Creators Scale, developed by Tarafdar et al. (2010) and adapted into Turkish by Bulut et al. (2023), was used to measure technostress^{23,24}. The scale consists of 22 items rated on a 5-point Likert scale and includes five subdimensions: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. Factor loadings ranged between 0.591 and 0.912, and model fit indices ($\chi^2/df=1.82$, CFI=0.902, IFI=0.904, RMSEA=0.071, SRMR=0.03) indicated acceptable fit. The Cronbach's alpha coefficient for the total scale was 0.89 in this study.

Work-Life Balance Scale (WLBS): The Work–Life Balance Scale, developed by Fisher, Bulger, and Smith (2009) and adapted into Turkish by Ekinci and Sabancı (2021), was used to assess participants' work–life balance^{25,26}. The scale consists of 17 items rated on a 5-point Likert scale and includes four subdimensions: work interference

with life, life interference with work, work enhancement of life, and life enhancement of work. The Cronbach's alpha coefficient for this study was 0.74.

Ethical Statement

This study was approved by the Ethics Committee of Istanbul Okan University (Decision No: 199, dated: March 4, 2026). The developers of the measurement instruments used in the study granted permission. Participants were told that the data collected would be used for scientific purposes only and written informed consent was obtained. They were also told that they could withdraw from the study at any moment.

Statistical Analysis

Data were analyzed using SPSS for Windows 25.0. Descriptive statistics (frequency, percentage, minimum–maximum values, mean, and standard deviation) were calculated. Normality was assessed by skewness and kurtosis coefficients. Parametric tests were applied when the data met normality assumptions. Independent samples t-tests and one-way analysis of variance (ANOVA) were used to compare differences between groups. Post hoc tests were performed with Tukey or Games–Howell depending on homogeneity of variances.

Pearson correlation analysis was used to analyze the relationships between variables, whereas multiple linear regression analysis was utilized to assess predictive relationships. A statistically significant value was established at $p < 0.05$.

Results

The study included 450 academic staff members as participants. The average age of the participants was 42.42 ± 10.37 years. Most were married (68.9%) and had a doctoral degree (83.3%). In terms of degree academic ranks, 23.8% were Assistant Professors, 23.1% were Professors and 21.6% were Research Assistants for professional experience, 27.3% had ≥ 21 years and 24.4% had 6–10 years.

Most participants (72.2%) were employed at state universities, and most of them also worked full-time (97.6%). The most reported weekly teaching load was 11–15 hours (28.4%), and the total weekly working time was 40–49 hours (48.7%). On the artificial intelligence (AI) usage side, 40.2% of participants have been using AI tools for 1–2 years, and 38.9% of them reported spending less than 2 hours per week on these tools. The primary purposes of AI use included translation (71.1%), academic writing and editing (64.0%), and literature review and preparation of course materials (56.0%). The most frequently used tools were ChatGPT (84.0%), Gemini (56.0%), and NotebookLM (30.4%). Those who used other tools accounted for 3.6%, while 5.6% reported using them for different purposes (Table 1).

Table 1. Results on the descriptive characteristics of individuals (n=450)

Sociodemographic Characteristics	Min-Max	Mean	Standard Deviation
Year	18-76	42.42	10.37
		Number (n)	Percentage (%)
Marital Status	Married	310	68.9
	Single	140	31.1
Education Level	Master's Degree	71	15.8
	Doctoral degree	375	83.3
	Others	4	0.9
Academic Title	Research assistant	97	21.6
	Lecturer	60	13.3
	Assistant Professor	107	23.8
	Associate Professor	82	18.2
	Professor	104	23.1
Professional Experience (Year)	0–5 years	86	19.1
	6–10 years	110	24.4
	11–15 years	85	18.9
	16–20 years	46	10.2
	21 years and over	123	27.3
Institution Type	State	325	72.2
	Private	125	2.8
Weekly Course Hours	0–5 hours	72	16.0
	6–10 hours	82	18.2
	11–15 hours	128	28.4
	16–20 hours	90	20.0
	21 hours and over	78	17.3
Weekly work hours	<40 hours	137	30.4
	40–49 hours	219	48.7
	50–59 hours	52	11.6
	≥60 hours	42	9.3
Time to start AI tools	<6 months	63	14.0
	6 – 12 months	133	29.6
	1–2 years	181	40.2
	>2 years	73	16.2
Frequency of using AI tools	<2 hours per week	175	38.9
	3–6 hours per week	153	34.0
	7–9 hours per week	58	12.9
	>10 hours per week	64	14.2

Purpose of using AI tools	Translation	320	71.1
	Writing articles	288	64.0
	Literature review	252	56.0
	Preparing course documents	252	56.0
	Data analysis	118	26.2
	E-mail communication	107	23.8
	Coding	64	14.2
	Others	16	3.6
Commonly used AI tools	ChatGPT	378	84.0
	Gemini	252	56.0
	NotebookLM	137	30.4
	Copilot	73	16.2
	Others	25	5.6

The mean total score of the participants on the Artificial Intelligence Addiction Scale (AIAS) was determined to be 11.12 ± 4.17 , and the mean total score on the Technostress Creators Scale (TCS) was 56.13 ± 12.85 . Among the sub-dimensions of the TCS, the highest mean score was for Techno-overload (14.11 ± 4.15), followed by Techno-complexity (12.82 ± 3.82) and Techno- uncertainty (10.32 ± 3.47); the lowest mean score belonged to the Techno-insecurity sub- dimension (8.67 ± 3.23). The mean total score on the Work-Life Balance Scale (WLBS) was 49.48 ± 8.14 , with the highest score among the sub-dimensions being Positive Effect of Work on Life (16.04 ± 5.27), followed by Positive Effect of Life on Work (13.91 ± 4.91), Negative Effect of Life on Work (10.34 ± 2.59), and Negative Effect of Work on Life (9.19 ± 2.81) (Table 2).

Table 2. Participants' results on AI addiction, technostress and work-life balance

Scales and Subdimensions	Number of Items	Min-Max	Mean $\pm$ SD
AI Addiction Scale	5	5.00-23.00	11.12 $\pm$ 4.17
Technostress Creators Scale	22	25.00-93.00	56.13 $\pm$ 12.85
Techno-Overload	5	5.00-25.00	14.11 $\pm$ 4.15
Terchno-Invasion	4	4.00-20.00	10.22 $\pm$ 4.06
Techno-Complexity	5	5.00-23.00	12.82 $\pm$ 3.82
Techno-Insecurity	4	4.00-20.00	8.67 $\pm$ 3.23
Techno-Uncertainty	4	4.00-20.00	10.32 $\pm$ 3.47
Work Life Balance Scale	17	19.00-74.00	49.48 $\pm$ 8.14
Negative Effect of Work on Life	5	5.00-25.00	16.04 $\pm$ 5.27
Negative Effect of Life on Work	6	6.00-30.00	13.91 $\pm$ 4.91
Positive Effect of Life on Work	3	3.00-15.00	10.34 $\pm$ 2.59
Positive Effect of Work on Life	3	3.00-15.00	9.19 $\pm$ 2.81

According to Pearson correlation analysis results, a moderately positive and significant relationship was found between the Artificial Intelligence Addiction Scale (AIAS) and the Technostress Creators Scale (TCS) ($r=0.421$, $p<0.01$). Similarly, a moderately positive and significant relationship was found between the AIAS and the Work-Life Balance Scale (WLBS) ($r=0.347$, $p<0.01$). The relationship between the TCS and the WLBS was also moderately positive and significant ($r=0.547$, $p<0.01$) (Table 3).

Table 3. Relationship between AI Addiction Scale, Technostress Creators Scale and Work-Life Balance Scale

AI Addiction Scale			Technostress Creators Scale	Work-Life Balance Scale
AIAS	r	1	.421*	.347*
	p		.000	.000
TCS	r	.421*	1	.547*
	p	.000		.000
WLBS	r	.347*	.547*	1
	p	.000	.000	

* $p<0.01$ significant

According to the independent samples t-test results, there was no significant difference ($p>0.05$) in the mean scores of the Artificial Intelligence Addiction Scale (AIAS), Technostress Creators Scale (TCS), and Work-Life Balance Scale (WLBS) among participants based on their marital status, type of institution, and employment type. One-way analysis of variance results showed a significant difference in AIAS scores based on education level ($F=4.759$, $p=0.009$); academics with master's degrees (12.48 ± 4.12) had higher AI addiction scores than those with doctoral degrees (10.88 ± 4.10). Significant differences were found in both AIAS ($F=9.028$, $p<0.001$) and WLBS ($F=6.145$, $p<0.001$) scores based on academic title. Research assistants had the highest AIAS scores (12.42 ± 4.04), while professors had lower AIAS (9.63 ± 3.98) and WLBS (46.48 ± 8.30) scores compared to other titles. In terms of academic seniority, academics with 0–5 years of experience had significantly higher AIAS and WLBS scores than those with 21 years or more of experience ($p<0.05$). Weekly teaching load only affected TCS scores ($F=5.543$, $p<0.001$), and academics with 16–20 and 21 hours or more of teaching load had higher technostress levels than those with 0–5 hours of teaching load. In addition, the frequency of using artificial intelligence tools affected AIAS scores; As weekly usage increased, the level of AI addiction level, and academics who used AI for 10 hours or more per week (14.25 ± 4.08) scored significantly higher than those who used it for 2 hours or less per week (9.82 ± 3.91) (Table 4).

Table 4. Comparison of AIAS, TCS and WLBS Scores according to participants' sociodemographic characteristics.

Sociodemographic characteristics	AIAS Mean±SD	TCS Mean±SD	WLBS Mean±SD
Marital Status			
Single	11.34±4.24	56.55±12.79	49.35±7.84
Married	11.02±4.15	55.95±12.90	49.53±8.28
Test & p	t=0.761, p=.447	t=0.462, p=.645	t=-0.220, p=.826
Institution Type			
Government	11.16±4.14	56.10±12.88	49.12±8.33
Private	11.02±4.27	56.23±12.83	50.40±7.55
Test & p	t=0.302, p=.763	t=-0.101, p=.920	t=-1.496, p=.135
Mode of operation			
Full time	11.10±4.18	56.15±12.90	49.43±8.15
Partial Time	11.91±3.80	55.36±11.20	51.45±7.43
Test & p	t=0.634, p=.526	t=0.201, p=.841	t=-0.816, p=.415
Education Level			
Master Degree	12.48±4.12	57.87±12.76	50.96±7.95
Doctoral Degree	10.88±4.10	55.87±12.87	49.25±8.20
Test & p	F=4.759, p=.009*	F=1.185, p=.307	F=2.010, p=.135
Academic Title			
Research assistant (a)	12.42±4.04	54.79±12.91	50.02±8.05
Lecturer (b)	11.83±4.05	58.80±12.74	49.77±7.95
Assistant Professor (c)	11.85±4.03	57.66±12.80	51.82±7.80
Associate Professor (d)	10.00±4.02	55.57±12.85	49.35±8.10
Professor(e)	9.63±3.98	54.71±12.88	46.48±8.30
Test & p	F=9.028, p<.001*	F=1.654, p=.160	F=6.145, p<.001*
	a, c > d, e		a, c > e
Professional Experience			
0–5 years(a)	12.48±4.02	54.92±12.90	49.50±8.05
6–10 years(b)	12.02±4.03	57.51±12.84	50.80±7.98
11–15 years(c)	11.46±4.05	57.87±12.76	51.53±7.90
16–20 years(d)	9.96±4.00	54.91±12.83	48.96±8.10
≥21(e)	9.57±3.97	55.01±12.89	47.05±8.25
Test & p	F=9.485, p<.001*	F=1.236, p=.295	F=5.036, p=.001*
	a, b, c > d, e		b, c > e
Weekly work hours			
0–5 hours	12.24±4.05	51.11±12.71	50.13±8.10
6–10 hours	10.46±4.08	53.60±12.82	48.91±8.04
11–15 hours	10.98±4.12	57.52±12.86	48.77±8.00
16–20 hours	11.48±4.09	58.78±12.89	50.20±8.02
≥ 21 hours	10.59±4.10	58.10±12.87	49.78±8.06

Test & p	F=2.334, p=.055	F=5.543, p<.001*	F=0.654,
		c, d, e > a	p=.624
Frequency of using AI tools			
≤2 hours per week	9.82±3.91	54.87±12.71	48.12±8.01
3–6 hours per week	12.86±4.02	56.42±12.83	49.95±8.02
7–9 hours per week	13.99±4.11	57.01±12.76	50.11±8.07
≥10 hours per week	14.25±4.08	57.22±12.90	50.28±8.12
Test & p	F=18.42, p<.001**	F=1.11, p=.345	F=0.89
		b, c, d > a	p=.448

*Tukey HSD applied **Games-Howell test applied

The regression model established in terms of factors affecting artificial intelligence addiction was found to be significant ($F(2, 447)=54.624, p<0.001$) and explained 19.6% of the variance in AIAS scores ($R^2=0.196$). The analysis showed that the Technostress Creators Scale (TCS) and the Work-Life Balance Scale (WLBS) were positive and significant predictors of AIAS; TCS ($\beta=0.330, t=6.511, p<0.001$) was the strongest predictor, followed by WLBS ($\beta=0.166, t=3.288, p=0.001$). The regression model based on technology use (TCS) was also found to be significant ($F(2, 447)=125.447, p<0.001$) and explained 36% of the variance in TCS scores ($R^2=0.360$). In this model, WLBS was determined as the strongest predictor of TCS ($\beta=0.455, t=11.287, p<0.001$), and AIAS came in second place ($\beta=0.263, t=6.511, p<0.001$). Similarly, the regression model examining the effects of WLBS and TCS on work-life balance scale (WLBS) was also found to be significant ($F(2, 447)=102.932, p<0.001$) and explained 31.5% of the variance in WLBS scores ($R^2 = 0.315$). In this model, TCS was the strongest predictor ($\beta=0.487, t=11.287, p<0.001$), followed by WLBS ($\beta = 0.142, t = 3.288, p = 0.001$) (Table 5).

Table 5. Multiple linear regression analysis of the Artificial Intelligence Addiction Scale (AIAS), the Techno-Stress Creators Scale (TCS), and the Work-Life Balance Scale (WLBS)

							%95 Confidence Interval	
AIAS	Independent Variable	B	SD	β	t	p*	Lower Limit	Upper Limit
	(Constant)	0.885	1.113	–	0.796	0.427	-1.303	3.073
	TS	0.107	0.016	0.330	6.511	0.001	0.076	0.138
	WLB	0.085	0.026	0.166	3.288	0.000	0.034	0.136
	$R=0.443 \ R^2=0.196 \ Adjusted \ R^2=0.193 \ F=54.624 \ p<0.001 \ Durbin-Watson=1.538$							
							%95 Confidence Interval	
TCS	Independent Variable	B	SD	β	t	p*	Lower Limit	Upper Limit

	(Constant)	11.538	3.012	–	3.831	0.000	5.62	17.45
	WLB	0.720	0.064	0.455	11.287	0.000	0.595	0.845
	AIA	0.809	0.124	0.263	6.511	0.000	0.566	1.052
	$R=0.600$ $R^2=0.360$ $Adjusted\ R^2=0.357$ $F=125.447$ $p<0.001$ $Durbin-Watson=2.081$							
							%95 Confidence Interval	
WLBS	Independent Variable	<i>B</i>	<i>SD</i>	β	<i>t</i>	<i>p</i> *	Lower Limit	Upper Limit
	(Constant)	29.097	1.456	–	19.985	0.000	26.24	31.95
	AIA	0.277	0.084	0.142	3.288	0.001	0.112	0.442
	TS	0.308	0.027	0.487	11.287	0.000	0.255	0.361

$R=0.562$ $R^2=0.315$ $Adjusted\ R^2=0.312$ $F=102.932$ $p<0.001$ $Durbin-Watson=2.011$

Discussion

In this study, it was found that there were positive correlations between AI addiction, technostress, and work-life balance. Furthermore, it was determined that AI addiction and technostress significantly predict work-life balance.

Discussion of Findings on AI Addiction, Technostress and Work-Life Balance

In the literature, it was emphasized that digitally literate professionals position AI not as a threat or an addictive element, but as a 'supportive tool' that enhances their performance²⁷. A recent study by Alhur et al. (2025) on educators in higher education also indicated that academics tended to verify and critically filter the content produced by AI tools, rather than passively consuming them²⁸.

In this study, it was revealed that academics generally experienced a moderate level of technostress. However, when the sources of stress were examined, the "Techno-overload" sub-dimension was the most dominant factor, while the "Techno-insecurity" sub-dimension was at the lowest level. As indicated in the study by Kumar et al. (2024), it was shown that technology was increasingly blurring the lines between work and private life²⁹.

Like other studies, this research showed that academic autonomy, knowledge, and professional status have a high impact on work-life balance, positively influencing employees' work-life balance¹⁰. Moreover, the fact that the 'Negative Impact of Life on Work' is higher than the interference of work with life was also consistent with research showing that family and personal responsibilities can affect the job performance of academics more in recent years³⁰. This situation suggested that the role conflict developing from life to work was becoming increasingly visible among academics.

Discussion of the Relationship Between Artificial Intelligence Addiction, Technostress, and Work-Life Balance

In the literature it was stated that artificial intelligence systems were initially used to reduce workload, but as use and addiction increase, they can trigger stress factors by creating a sense of loss of professional autonomy and control in individuals²⁸.

The significant relationship found between artificial intelligence addiction and work-life balance in this study was compatible with studies showing that digital transformation and artificial intelligence tools disrupt the balance between professional and social roles by leading individuals towards a 'culture of being online at all times'¹⁰. This situation suggested that as academics integrate artificial intelligence into work processes and the level of addiction to these tools increases, the intrusive effect of technology on personal time and psychological recovery may also increase.

The most striking finding of the study, which differs from the general trend in the literature, was the positive relationship found between technostress and work-life balance. Although much of the existing literature suggested that technostress disrupts the work-life balance by consuming personal time^{17,18}, the results of this study indicated that academics have a high capacity for balance even under technological pressure. The last point may explain the finding that academics also experience less burnout despite increasingly having adverse demands to technology over time. While some earlier studies carried out in the context of COVID-19 much like our own found a negative impact of technostress on academics through increasing workload, complexity, uncertainty and technology-related burden^{31,32}, these studies also imply that technostress is not a constant state but may abate as individuals become more experienced with digital technologies. Accordingly, Boyer-Davis and Berry (2022) presented that faculty embraced less technostress over time, especially with improved computer anxiety, suggesting prolonged exposure to technology may elicit adaptation³¹. In addition, it seems that organizational factors are crucial protective factors. The positive effect of supportive organizational environments and institutional technical support is confirmed by earlier studies indicating that these conditions reduce technostress³³ and lead to efficient work practices among university teachers. So, it is possible that academic in the present study was able to balance their work–life in spite of facing technostress as along with technological demands there were also adaptation and organizational support which were not limited to an occupational stressor. The increased use of artificial intelligence by academics who manage to maintain work-life balance can be interpreted as them using these technologies as a "productivity tool" that facilitates their lives and creates personal time for themselves². In a cross-sectional study conducted with 651 academics in China, academics stated that they use artificial intelligence not only because it is "logical," but also they want to improve themselves, feel independent, or are open to innovation³⁴. This situation showed that the use of artificial intelligence can be considered not only a risk factor for academics but also a functional tool that helps balance workload.

Discussion of AI Addiction, Technostress, and Work-Life Balance Levels According to Sociodemographic Characteristics

In the present study, AI addiction scores were significantly higher among academics holding a master's degree and research assistants than among PhD holders and professors. This finding suggests that AI tools may be adopted more extensively as a strategic adaptation resource during the early stages of an academic career. One possible explanation is that early-career academics experience greater pressure to achieve academic productivity and meet institutional performance expectations, leading them to rely more heavily on AI tools. Consistent with this interpretation, previous research has reported that academics facing institutional performance expectations and publication pressure increasingly use AI tools to cope with expanding workloads and often perceive these technologies as a "lifeline"²⁸. In contrast, it is noteworthy that professors and senior academics have low AI addiction scores but significantly weaker work-life balance scores compared to other groups. Indeed, the literature indicates that artificial intelligence tools provide academics with significant time savings by automating intensive administrative and academic tasks²⁸. However, Cazan et al. (2024) emphasized that older and more experienced academic staff may have lower levels of digital literacy, making adaptation to new technologies more difficult and stressful for them³⁵. Therefore, the findings strongly supported the thesis of Klimova and Pikhart (2025) that the increase in the level of "addiction" to artificial intelligence observed in young academics may actually be a strategic coping factor that alleviates the stress created by academic workload and protects professional well-being⁵. When the relationship between weekly teaching load and technostress was examined, it was observed that technostress increased significantly as the teaching load increased. Akbar et al. (2025) stated that the expectation of constant accessibility brought about by digital transformation leads to cognitive overload and technological burnout in educators with heavy teaching loads¹⁰. This finding aligns with the view that technological stress stems not only from the tool itself but also from the tool being placed as an additional 'work demand' on an already existing workload²⁹.

Finally, the study found that while addiction scores increased with the frequency of AI tool use, this did not significantly affect technostress or work-life balance. This suggested that even if the duration of AI use increases, academics believe this process does not create a "technological invasion," but rather demonstrates controlled use. The literature emphasized that when individuals have high levels of 'technological self-efficacy' and digital resilience, they can successfully manage this process without experiencing stress, even if the duration and intensity of technology use increase²³. Although the high level of education and analytical skills of academics may have turned the duration of artificial intelligence use into an addiction, thanks to their self-efficacy, they may have transformed this situation from a destructive stress into a stimulating force, defined in the literature as positive stress^{36,37}.

Discussion of Findings Regarding the Prediction of AI Addiction in Terms of Technostress and Work-Life Balance

When the factors predicting AI addiction were examined in the study, it was seen that

both technostress and work-life balance significantly and positively affected this addiction. In the literature, the potential of artificial intelligence to reduce workload and automate processes for academics was emphasized as the main driving force behind the trend towards these tools³⁸. In this context, Alhur et al. (2025) stated that educators under high performance expectations and publication pressure become dependent on artificial intelligence with the motivation to cope with increasing workload and speed up work processes²⁸.

The results obtained in the context of the predictors of technostress revealed that both work-life balance and AI addiction increase the level of technostress. The literature suggested that the effort to balance work and private life using technological tools paradoxically triggers feelings of "technological invasion" and "overload." High dependence on AI tools forces academics into continually digital interaction and increases mental fatigue, which is a primary component of technostress¹⁸. Bottaro et al. (2024) demonstrated that excessive technology use deprived the work environment of spatial and temporal boundaries; this case blurred the line between professional demands and private life, significantly disrupting work-life balance¹⁸. Studies by Agarwal and Goel (2024) indicated that the positive effects of AI on workload management and efficient time management allowed employees to create personal time for themselves³⁹. In conclusion, AI addiction and technostress function not as burnout factors for academics but rather as strategic components used to harmonize work and private life roles in the digital age.

Conclusion

This study suggested that the relationship between academics in Turkey, which is at the center of digital transformation, have with artificial intelligence (AI) tools was not only a destructive source of "addiction" or "stress" from the perspective of employee health, as it was commonly believed, but can also function as a strategic mechanism that harmonizes professional and personal life. The most fundamental finding obtained because of the research was that academics use AI tools not as an uncontrolled and pathological tendency, but as a "productivity lever" that alleviates the workload under the pressure of academic productivity. The conclusion reached because of the analyses, that "technostress and artificial intelligence addiction positively affect work-life balance," draws a unique "academic adaptation" picture, deviating from the traditional approaches in the literature that technostress always disrupts the balance.

When sociodemographic findings were examined, it was seen that young academics and research assistants, thanks to their digital aptitude, manage their workloads by turning more towards AI, thus creating time for their private lives (maintaining work-life balance). To conclude, heavy use (addiction) of academics to AI is essentially a "functional adaptation" device designed to cope with the increasing pace and manage the boundaries between work-life and private life in the digital age. But this functional use also conceals long-term hidden dangers to mental health, such as cognitive fatigue, loss of professional autonomy, and the pressure of being "always available."

Recommendations

University administrations should consider the AI integration process not merely through a technical infrastructure lens, but as an exercise in developing "human-centered" policies that promote employee well-being. The foundation of a secure digital working environment should be developed to help academics see AI as an ally rather than an adversary. Institutional-level initiatives are necessary: continuous training in digital literacy and technical support mechanisms to minimize technostress levels and strengthen technological adaptation of older and more senior academics should be applied. To counteract the "always being on" phenomenon caused by digitalization, academics should regulate their digital accessibility (email, messages from students, etc.) beyond working hours, and institutional limits should be set to allow for a clear distinction between work life and private life. Academics should refrain from giving up their own pedagogical autonomy and critical thinking skills by submitting to the comforts of AI tools by employing a "critical evaluator" stance when using these tools, confirming content rather than passively consuming them. Technology breaks should be scheduled throughout the day when you fully disconnect from your screens and digital notifications to avoid cognitive overload and mental fatigue.

Limitations and Future Research

This study is a cross-sectional survey and does not reflect changes over time. Future research could also incorporate longitudinal studies to monitor the long-term impacts of AI usage on academics (e.g., potential risks for burnout or loss of autonomy that may emerge over time).

Acknowledgements: No financial support was received for this study.

Conflict of Interest: The authors declare that they have no conflicts of interest.

REFERENCES

1. Avci O. Yapay zekâ bağımlılığı. In: *Proceedings of the 4th International Turkic World Congress on Social, Humanities, Administrative, and Educational Sciences*; 2025:1291-1297.
2. Pantic IV. Introducing the AI addiction scale (AIAS-21): A screening tool for problematic AI use. *Eur Child Adolesc Psychiatry*. 2026;35(1):297. doi: 10.1007/s00787-025-02874-8.
3. El-Sayed AAI, Alsenany SA, Asal MGR, Alasqah I. Development and validation of Artificial Intelligence Addiction Scale for researchers: A methodological study. *J Nurs Manag*. 2025;2025:8458533. doi: 10.1155/jonm/8458533.
4. Griffiths MD. A "components" model of addiction within a biopsychosocial

- framework. *J Subst Use*. 2005;10(4):191-197. doi: 10.1080/14659890500114359.
5. Klimova B, Pikhart M. Exploring the effects of artificial intelligence on student and academic well-being in higher education: A mini-review. *Front Psychol*. 2025;16:1498132.
 6. Kooli C, Kooli Y, Kooli E. Generative artificial intelligence addiction syndrome: A new behavioral disorder? *Asian J Psychiatr*. 2025;107:104476. doi: 10.1016/j.ajp.2025.104476.
 7. Zhang S, Zhao X, Zhou T, Kim JH. Do you have AI dependency? The roles of academic self-efficacy, academic stress, and performance expectations on problematic AI usage behavior. *Int J Educ Technol High Educ*. 2024;21:34. doi: 10.1186/s41239-024-00467-0.
 8. Malik AS, Acharya S, Humane S. Exploring the impact of security technologies on mental health: A comprehensive review. *Cureus*. 2024;16(2):e53664. doi: 10.7759/cureus.53664.
 9. Chaudhry MA, Kazim E. Artificial intelligence in education (AIED): A high-level academic and industry note. *AI Ethics*. 2022;2(2):157-165. doi: 10.1007/s43681-021-00074-z.
 10. Akbar MA, Varias V, Risa TD, Bhirawa MA, Nugraha R. Workplace stress in the era of digital transformation: A psychological approach to employee well-being. *RIGGS J Artif Intell Digit Bus*. 2025;4(3):2493. doi: 10.31004/riggs.v4i3.2493.
 11. Tarafdar M, Tu Q, Ragu-Nathan BS, Ragu-Nathan TS. The impact of technostress on role stress and productivity. *J Manag Inf Syst*. 2007;24(1):301-328. doi: 10.2753/MIS0742-1222240109.
 12. Tarafdar M, Cooper CL, Stich JF. The technostress trifecta—techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Inf Syst J*. 2019;29(1):6-42. doi: 10.1111/isj.12169.
 13. Trenerry B, Chng S, Wang Y, et al. Preparing workplaces for digital transformation: An integrative review and framework of multi-level factors affecting employee wellbeing. *Int J Hum Resour Manag*. 2021;32(1):1-28. doi: 10.1080/09585192.2020.1817058.
 14. Ayyagari R, Grover V, Purvis R. Technostress: Technological antecedents and implications. *MIS Q*. 2011;35(4):831-858.
 15. Patra K, Bansal S. Yükseköğretimde akademik personelin refahı üzerinde teknostresin etkisinin değerlendirilmesi. *Bilisim Egitimi ve Arastirma Dergisi*. 2025;5(1):2305.

16. Truța C, Maican CI, Cazan AM, Lixândroiu RC, Dovleac L, Maican MA. Always connected @ work: Technostress and well-being with academics. *Comput Human Behav.* 2023;143:107675. doi: 10.1016/j.chb.2023.107675.
17. Bencsik A, Juhasz T. Impact of technostress on work-life balance. *Hum Technol.* 2023;19(1):4-21. doi: 10.14254/1795-6889.2023.19-1.4
18. Bottaro R, De Giovanni K, Faraci P. The extent to which technostress is related to employees' work-life fit: A multilevel meta-analysis. *Workplace Health Saf.* 2024;72(10):421-430. doi: 10.1177/21650799241264317
19. Wang Q, Yao N. Understanding the impact of technology usage at work on academics' psychological well-being: A perspective of technostress. *BMC Psychol.* 2025;13(1):246.
20. Wang Q, Yao N. The impact of technostress creators on novice teachers' job satisfaction. *J Educ Teach.* 2023;49(1):104-119. doi:10.1080/02607476.2021.2013712.
21. Gökbulut B. The relationship between teachers' technostress and their technopedagogical competence. *Ahi Evran Univ Kirsehir Educ Fac J.* 2021;22(1):472-496.
22. Morales-García WC, Sairitupa-Sanchez LZ, Morales-García SB, Morales-García M. Development and validation of a scale for dependence on artificial intelligence in university students. *Front Educ.* 2024;9:1323898. doi:10.3389/educ.2024.1323898
23. Savas BC. Yapay Zekâya Bağımlılık Blçeğinin Türkçe'ye uyarlanması: Geçerlik ve güvenilirlik çalışması. *Herkes İçin Spor ve Rekreasyon Dergisi.* 2024;6(3):306-315.
24. Tarafdar M, Tu Q, Ragu-Nathan TS. Impact of technostress on end-user satisfaction and performance. *J Manage Inf Syst.* 2010;27(3):303-334. doi:10.2753/MIS0742-1222270311
25. Bulut A, Sengul H, Akbal S. Sağlık profesyonelleri için teknostres yaratıcıları ölçeği Türkçe formunun psikometrik özellikleri. *J Acad Res Nurs.* 2023;9(3):223-233.
26. Fisher GG, Bulger CA, Smith CS. Beyond work and family: A measure of work/nonwork interference and enhancement. *J Occup Health Psychol.* 2009;14(4):441-456.
27. Ekinçi H, Sabancı A. İş-yaşam Dengesi Ölçeği'nin Türkçeye uyarlanması: Geçerlik ve güvenilirlik çalışması. *Trakya Eğitim Dergisi.* 2021;11(1):151-163.

28. Khalid MA, Sohail M, Baig MMB, Yusaf S, Iqbal A, Syed MI. The human-centric paradox of AI in HRM: How technostress and digital literacy co-determine employee productivity in smart work environments. *Inverge J Soc Sci*. 2025;4(4):214-227.
29. Alhur A, Khlaif ZN, Hamamra A, Hussein M. The paradox of AI in higher education: A qualitative inquiry into AI dependency among educators in Palestine. *Educ Inf Technol*. Epub ahead of print 2025. doi: 10.1007/s10639-025-13596-y.
30. Kumar PS. Technostress: A comprehensive literature review on dimensions, impacts, and management strategies. *Comput Hum Behav Rep*. 2024;16:100475.
31. Taylor H, Smith M, Jones A, et al. Work-life balance among health administration faculty before and during the COVID-19 pandemic. *J Health Adm Educ*. 2022;39(1):127-142.
32. Boyer-Davis S, Berry K. Technostress creators in higher education during the COVID-19 pandemic: A comparison of faculty perceptions and experiences. *J Higher Educ Theory Pract*. 2022;22(10):1-16. doi: 10.33423/jhetp.v22i10.5383
33. Khlaif ZN, Khalili F, Affouneh S, Tlili A. How remote learning during crisis affect technostress levels experienced by academicians. *Educ Inf Technol (Dordr)*. 2023;28(9):11075-11100. doi: 10.1007/s10639-023-11651-6.
34. Khan AA, Jamil A, Bakhsh K. Role of organizational environment in reducing the effect of techno-stress on work behavior of the university teachers. *Glob Soc Sci Rev*. 2020;5(1):313-321. doi: 10.31703/gssr.2020(V-I).32.
35. Luo Y, Day MJ. Determinants of lecturer readiness to adopt generative AI in higher education: Survey evidence from UTAUT and self-determination theory. *Educ Inf Technol*. Epub ahead of print 2026.
36. Cazan A, David LT, Truta C, Maican C, Henter R, Nastasa LE. Technostress and time spent online: A cross-cultural comparison for teachers and students. *Front Psychol*. 2024;15:1377200. doi: 10.3389/fpsyg.2024.1377200.
37. Kumar R, Khedwal A, Goud S, Mahulkar A, Sharma S. The impact of technologies on work-life balance. *ShodhKosh J Visual Perform Arts*. 2024;5(1):2242-2252.
38. Malik A, Islam SU, Aleem M, Tariq N. An empirical investigation of technostress due to technological factors and its impact on employee engagement. *J Posit Sch Psychol*. 2022;6(2):6562-6582.
39. Tlili A, Shehata B, Adarkwah MA, et al. What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learn Environ*. 2023;10(1):15.

The Relationship between Nurses' Work Environment Characteristics, Job Performance and Patients' Satisfaction with Nursing Care*

Filiz ÖZBEY**, Betül SÖNMEZ***

Abstract

Aim: This research aimed to examine the relationship between nurses' work environment characteristics, their job performance and patients' satisfaction with nursing care.

Method: A cross-sectional, descriptive and correlational design was used. The study included 367 nurses working in internal medicine and surgical wards across three training and research hospitals in Istanbul, along with 538 inpatients. Participants were selected using a proportional quota sampling method. Data from nurses were collected using the Nurse Information Form, the Practice Environment Scale of the Nursing Work Index and the Task Performance Scale. Patient data were obtained using the Patient Information Form and the Newcastle Satisfaction with Nursing Care Scale. Descriptive statistics, intergroup comparison tests and correlation analyses were applied to examine the relationships among variables.

Results: Nurses' perceptions of their work environment were slightly above average while their self-reported job performance and patients' satisfaction with nursing care were high. Patients' satisfaction was higher in units where nurses worked an average of ≤ 45 hours per week, the nurse-to-bed ratio was ≤ 2 and nurses cared for ≤ 18 patients per shift ($p < 0.05$). However, no significant correlations were found between nurses' perceived work environment, their job performance and patients' satisfaction with nursing care ($p > 0.05$).

Conclusion: This study identifies work-related characteristics of nurses that influence patients' satisfaction with nursing care and provides useful findings for hospital administrators to improve patients' satisfaction. It is recommended that administrators who wish to increase patients' satisfaction ensure that the average weekly working hours of nurses, the nurse-to-bed ratio and the average number of patients cared for per shift are within ideal limits.

Özgün Araştırma Makalesi (Original Research Article)

Geliş / Received: 24.03.2026 Kabul / Accepted: 03.08.2026

DOI: <https://doi.org/10.38079/igusabder.1915432>

* This study has been derived from the master's thesis titled "The relationship between work environment characteristics and nurses' job performance and patients' care satisfaction", which was accepted in 2019 at Istanbul University-Cerrahpaşa Institute of Graduate Studies Department of Nursing Management and prepared by Filiz ÖZBEY under the consultancy of Assoc. Prof. Dr. Betül SÖNMEZ ; This study titled "The relationship between nurses' work environment characteristics and job performance and patients' care satisfaction", which was presented as a oral presentation at the 8th International Nursing Management Congress, 27-29 October 2022, Istanbul, Türkiye.

** RN, MSc, Istanbul University-Cerrahpaşa, Institute of Graduate Education, Doctorate Program in Department of Nursing Management, Istanbul, Türkiye. E-mail: filiz.ozbey93@gmail.com ORCID <https://orcid.org/0000-0003-4562-6579>

*** Assoc. Prof. Dr., Istanbul University-Cerrahpaşa, Florence Nightingale Faculty of Nursing, Department of Nursing Management, Istanbul, Türkiye. E-mail: betul.sonmez@iuc.edu.tr ORCID <https://orcid.org/0000-0002-6091-4993>

ETHICAL STATEMENT: The protocol was approved by the Istanbul University Social Sciences and Humanities Research Ethics Committee, Türkiye (Number: 10, Date: 05.11.2018). A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant.

Keywords: Nurses, work performance, inpatients, nursing care, patient satisfaction.

Hemşirelerin Çalışma Ortamı Özellikleri ve İş Performansı ile Hastaların Bakım Memnuniyeti Arasındaki İlişki

Öz

Amaç: Bu çalışmanın amacı, hemşirelerin çalışma ortamı özellikleri ve iş performansı ile hastaların bakım memnuniyeti arasındaki ilişkinin incelenmesidir.

Yöntem: Kesitsel, tanımlayıcı ve ilişki arayıcı tasarımda olan çalışma örneklemini orantılı kota örnekleme yöntemi ile, İstanbul'daki üç eğitim ve araştırma hastanesinin dahili ve cerrahi servislerinde çalışan 367 hemşire ve yatarak tedavi gören 538 hasta oluşturdu. Hemşirelerin verileri, Hemşire Bilgi Formu, Hemşirelik İş İndeksi-Hemşire Çalışma Ortamını Değerlendirme Ölçeği, Görev Performansı Ölçeği; hastaların verileri, Hasta Bilgi Formu ve Newcastle Hemşirelik Bakım Memnuniyet Ölçeği ile toplandı. Çalışma verilerinin analizinde, tanımlayıcı testler, gruplar arası karşılaştırma testleri ve korelasyon analizi kullanıldı.

Bulgular: Hemşirelerin çalışma ortamı değerlendirmesi ortalamanın biraz üzerinde, hemşirelerin iş performansı ve hastaların hemşirelik bakım memnuniyeti yüksek saptandı. Hemşirelerin haftalık ortalama çalışma süresinin ≤ 45 saat olduğu, yatak başına düşen hemşire oranı ≤ 2 ve bir vardiyada bakılan ortalama hasta sayısının ≤ 18 olduğu birimlerde hastaların hemşirelik bakım memnuniyeti anlamlı olarak daha yüksek saptandı ($p < 0,05$). Hemşirelerin çalışma ortamı değerlendirmesi, iş performansı ve hastaların bakım memnuniyeti puanları arasında anlamlı ilişki saptanmadı ($p > 0,05$).

Sonuç: Bu çalışma, hastaların hemşirelik bakım memnuniyetini etkileyen hemşirelerin çalışma özelliklerini ortaya koymakta olup hastaların bakım memnuniyetini artırmaya yönelik hastane yöneticilerine faydalı bulgular sunmaktadır. Hastaların bakım memnuniyetini artırmak isteyen yöneticilerin; hemşirelerin haftalık ortalama çalışma saatlerinin, yatak başına düşen hemşire oranının ve bir vardiyada bakılan ortalama hasta sayısının ideal sınırlarda olmasını sağlaması önerilmektedir.

Anahtar Sözcükler: Hemşireler, iş performansı, yatan hastalar, hemşirelik bakımı, hasta memnuniyeti.

Introduction

Improving healthcare quality remains a central objective for healthcare systems since it influences both institutional effectiveness and patient outcomes. The Structure–Process–Outcome model proposed by Avedis Donabedian is widely recognized as a foundational framework for evaluating healthcare quality. Within this model, structural components of healthcare organizations shape care processes, which influence patient outcomes¹. In this context, nurses' work environment characteristics represent the structural dimension of healthcare services, while nurses' job performance is considered an important indicator of the care process. Patients' satisfaction with nursing care represents an important outcome indicator. The nursing work environment has been defined as “the organizational characteristics of a work environment that facilitate or limit professional nursing practice”². A healthy work environment enables nurses to prevent errors, manage physical demands and access necessary assistance when needed³. To support optimal nursing practice, work environments must provide adequate staffing and resources, strong administrative support and collaborative relationships between

nurses and physicians⁴. The work environment directly affects nurses' professional motivation, burnout levels and commitment to the profession. Supportive management, adequate staffing and resources and collaborative team dynamics all strengthen nurses' capacity to work effectively and efficiently^{3,4}. Organizational initiatives aimed at improving working conditions are therefore key strategies for enhancing nurses' job performance and consequently, patient outcomes⁴. Sarıköse and Göktepe identified significant relationships between nurses' perceptions of their work environment and their job performance. Their findings showed that factors such as managerial support, adequacy of staffing and resources and the foundations of nursing care quality were particularly influential. Sarıköse and Göktepe also found that nurses in units with adequate staffing and resources perceived their job performance to be higher⁵. The work environment plays a critical role in shaping nurses' job performance, which is defined as the effectiveness with which nurses carry out their responsibilities in delivering direct patient care⁶. High nurse job performance plays a central role in influencing patient satisfaction and health outcomes, making it a critical component of quality healthcare delivery⁷. Patients' satisfaction with nursing care is widely regarded as a key indicator of healthcare quality and an important health outcome. It is a multidimensional construct including patients' perceptions and attitudes toward all aspects of the healthcare services they receive⁸. Patient satisfaction with nursing care has also been defined as the degree of congruence between expected care and the actual care provided⁹. As an internationally recognized measure, patient satisfaction requires regular assessment to ensure the effective functioning of health systems. Such assessments help identify patient needs more accurately and guide ongoing improvements in care quality¹⁰. Similarly, Agostinho et al. found that nurses' technical competence, attentiveness and responsiveness were positively associated with patient satisfaction, demonstrating that the work environment is a critical determinant not only of nurses' job performance but also of the quality of patient experiences¹¹. Although research examining nursing work environments and job performance has expanded in recent years, studies focusing on these variables together with patients' satisfaction with nursing care remain limited. Addressing this gap, the present study examines the relationships among nurses' work environment characteristics, job performance and patients' satisfaction with nursing care. The research questions were as follows:

1. Is there a relationship between “nurses' work environment characteristics and their job performance”?
2. Is there a relationship between “nurses' work environment characteristics and patients' satisfaction with nursing care”?
3. Is there a relationship between “nurses' job performance and patients' satisfaction with nursing care”?
4. Is there a relationship between “nurses' work-related characteristics and patients' satisfaction with nursing care”?

Material and Methods

Study Aim and Design

This study used a descriptive, correlational and cross-sectional design to examine the relationships among nurses' work environment characteristics, job performance and patients' satisfaction with nursing care.

Sample and Settings

The study population comprised nurses and inpatients from the internal medicine and surgical wards of three training and research hospitals providing tertiary healthcare services on the European side of Istanbul. The nurse population included 632 participants distributed across the hospitals as follows: Hospital 1=148, Hospital 2=214 and Hospital 3=270. Patients hospitalized in these wards during the data collection period were also included.

The minimum required sample size for the nurse cohort was calculated as 239, based on a 95% confidence interval and a margin of error of $\alpha=0.05$, using a formula for known population sampling. A proportional quota sampling method was employed to select the nurse sample. This method was chosen because, among non-probability sampling techniques, it provides a more representative reflection of the population¹². To implement the quota sampling, the hospitals were treated as quota groups and the proportion of nurses in the internal and surgical wards of each hospital were used to determine the minimum sample sizes. Accordingly, at least 56 nurses were recruited from Hospital 1, 81 from Hospital 2 and 102 from Hospital 3, with a total minimum sample of 239 nurses. Inclusion criteria for the nurse sample were: providing care to inpatients in the internal or surgical wards, having at least six months of professional experience and voluntarily agreeing to participate in the study. Questionnaires were then distributed using convenience sampling to nurses who met these criteria. Of the 370 nurses who received the questionnaires, 367 completed them fully and were included in the final sample (Hospital 1=81, Hospital 2=107, Hospital 3=179), resulting in a response rate of 99.2%.

For the patient sample, the minimum required sample size was calculated as 384 using a formula for sampling with an unknown population size. Inclusion criteria for patients were: hospitalization in the internal or surgical wards of the participating hospitals, receiving inpatient care for at least two nights, being conscious and free of communication barriers, literate in Turkish, aged 18 years or older, physically and cognitively able to participate and providing voluntary informed consent. Since the number of inpatients across the hospitals was comparable, a minimum of 128 patients were recruited from each hospital. Using convenience sampling, a total of 538 patients met the inclusion criteria and were enrolled, resulting in a 100% response rate. Overall, the final sample corresponded to an average nurse-to-patient ratio of 1:1.47.

Data Collection and Instruments

Data were collected concurrently from March to June 2019 from both nurses and the patients under their care. Nurse-related information was obtained using the Nurse Information Form, the Practice Environment Scale of the Nursing Work Index (PES-NWI) and the Task Performance Scale (TPS). Patient-related data were collected using the Patient Information Form and the Newcastle Satisfaction with Nursing Care Scale (NSNCS).

Nurse Information Form: consisted of 13 items designed to assess personal characteristics of nurses (e.g., gender), professional background (e.g., total professional experience) and work-related conditions (e.g., nurse-to-bed ratio).

Practice Environment Scale of the Nursing Work Index (PES-NWI): originally developed by Lake, was used to assess nurses' perceptions of their work environment². The instrument consists of 31 items grouped into five subscales: "Nurse Participation in Hospital Affairs" (NPHA), "Nursing Foundations for Quality of Care" (NFQC), "Nurse Manager Ability, Leadership and Support of Nurses" (NMALSN), "Staffing and Resource Adequacy" (SRA), "Collegial Nurse-Physician Relations" (CNPR). Items are rated using a four-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). During scoring, responses are reverse-coded by subtracting each item score from five. As a result, higher scores reflect stronger agreement with the statements, while lower scores indicate disagreement. In the original study, the scale demonstrated satisfactory reliability, with Cronbach's alpha coefficients ranging from 0.71 to 0.84 across subscales and 0.82 for the overall instrument². Content validity was established by three experts experienced in magnet hospital research, while construct validity was tested through comparisons between nurses employed in magnet and non-magnet hospitals. The Turkish validity and reliability study conducted by Türkmen et al. reported Cronbach's alpha values ranging from 0.80 to 0.87 across subscales and 0.94 for the total scale¹³. In the present study, internal consistency coefficients ranged from 0.73 to 0.79 for the subscales, and 0.90 for the total scale.

Task Performance Scale (TPS): developed by Goodman and Svyantek, was used to assess nurses' job performance¹⁴. Originally designed for managers to evaluate employees' task-related performance, the scale consists of a single factor with nine items, rated on a 7-point Likert scale (1=strongly disagree, 7=strongly agree). Lower scores indicate weaker performance in the evaluated tasks, while higher scores reflect stronger task performance. The original instrument demonstrated high internal consistency, with a Cronbach's alpha of 0.93¹⁴. Permission was obtained from the original developers of the scale to use the instrument for self-assessment of employees' performance, after which it was adapted into Turkish¹⁵. The Turkish adaptation was validated for language and content and construct validity analyses indicated good model fit across all indices. The internal consistency was excellent, with a Cronbach's alpha of 0.94¹⁵. In the present study, the scale similarly demonstrated high reliability, with a Cronbach's alpha of 0.93 for the total score.

Patient Information Form: consisted of nine items designed to assess demographic characteristics of patients (e.g., age) as well as hospitalization-related information (e.g., diagnosis).

Newcastle Satisfaction with Nursing Care Scale (NSNCS): developed by Thomas et al., is a 19-item single-factor instrument used to assess patients' satisfaction with nursing care. Each item is scored on a five-point Likert scale ranging from 1 ("not satisfied at all") to 5 ("completely satisfied"). Total scores are calculated and converted to a scale ranging from 0 to 100. Higher scores indicate greater levels of satisfaction, while a score of 100 represents complete satisfaction with all dimensions of nursing care. The original version of the NSNCS demonstrated excellent internal reliability, with a Cronbach's alpha coefficient of 0.96¹⁶. Content validity was established through patient evaluations, and construct validity was confirmed using known-groups comparisons based on variables including age, educational status and the number of nurses involved in patient care. The Turkish adaptation conducted by Akin and Erdogan also reported high internal consistency (Cronbach's alpha=0.96)¹⁷. In the present study, the scale demonstrated strong reliability, with a Cronbach's alpha of 0.93.

Ethical Statement

Ethical approval for this study was obtained from the "Istanbul University Social Sciences and Humanities Research Ethics Committee" (Date: 05.11.2018; Number: 10). Permissions to use the measurement instruments was obtained via email from the original developers of the Task Performance Scale and from the authors responsible for the Turkish adaptations of the other scales. Institutional approval to conduct the study in the selected hospitals was granted by the Istanbul Provincial Directorate of Health. Informed voluntary consent forms were provided to all participants -both nurses and patients- and were signed prior to participation. To ensure confidentiality, the data collection instruments were distributed in sealed envelopes by the researcher.

Data Analysis

Data normality was assessed using the Shapiro-Wilk test and further examined through visual inspection of Q-Q plots and histograms. All statistical analyses were performed using IBM SPSS Statistics 22 (IBM SPSS, Türkiye) and the mediation package in R version 3.5.2 (R Core Team, 2018). Descriptive statistics were presented as means, standard deviations, frequencies, percentages and minimum–maximum values. For group comparisons, independent samples t-tests were applied for two-group analyses. Pearson correlation analysis was performed to examine relationships between scale scores. In addition, to evaluate the association between nurses' PES-NWI and TPS scores and patients' satisfaction, the mean NSNCS scores of patients cared for by each nurse were calculated and matched to the corresponding nurse.

Results

Of the 367 nurses included in the study, 81.5% were female and 56.9% were aged 25 years or younger, with a mean age of 27.31 years (SD=6.72; range:19–60 years). Most nurses were single (76.6%) and held a bachelor's degree (73.6%). The majority (91.6%) were employed as staff nurses, 58.3% worked in surgical units and 82.3% were assigned to rotating day–night shifts. Nurses had a mean length of employment at their current institution of 3.38 years (SD=5.79; range:0.6–32) and a mean total professional experience of 5.01 years (SD=7.22; range:0.6–36).

Regarding work-related characteristics, 73.3% of nurses reported working an average of ≤ 45 hours per week, 63.8% were in units with a nurse-to-bed ratio greater than 2 and 55.0% cared for ≤ 18 patients per shift. On average, nurses worked 43.73 hours per week (SD=5.74; range:40–76), in units with 31.57 beds (SD=16.66; range:9–93) and 13.99 nurses per unit (SD=7.02; range:3–34). The mean nurse-to-bed ratio was 2.36 (SD=0.74; range:1.1–6) and nurses cared for an average of 18.25 patients per shift (SD=10.53; range:4–93).

Among the 538 patients, 56.1% were female, 61.2% were younger than 65 years. Most patients were married (70.4%), had completed primary education (45.7%) and 37.4% were homemakers. The mean age of patients was 56.51 years (SD=18.58; range:18–98). Hospital distribution showed that 44.1% were admitted to Hospital 3, 56.5% were in surgical wards and 20.4% had gastrointestinal system-related diagnoses. The majority (87.5%) were accompanied by a companion during hospitalization. Patients stayed an average of 9.77 nights (SD=14.76; range:2–150) in the hospital.

The mean patients' satisfaction with nursing care scores differed significantly according to work-related characteristics of nurses ($p < 0.05$). Patients cared for by nurses working ≤ 45 hours per week ($p = 0.023$; $p < 0.05$), in units with a nurse-to-bed ratio of ≤ 2 ($p = 0.001$; $p < 0.01$) and in units where nurses cared for ≤ 18 patients per shift ($p = 0.024$; $p < 0.05$) reported significantly higher mean NSNCS scores compared with patients in other units (Table 1).

Table 1. Correlations between work-related characteristics of nurses and patients' NSNCS scores.

Work-related characteristics of nurses		Mean (SD)	The test value and p
Average weekly working hours	≤ 45 hours	83.73 (17.38)	t= 2.286; p= 0.023*
	>45 hours	78.99 (18.14)	
Nurse-to-bed ratio	≤ 2	90.09 (14.81)	t= 6.540; p= 0.001**
	>2	78.16 (17.76)	
Average patient load per shift (n)	≤ 18 patients	84.35 (18.18)	t= 2.266; p= 0.024**
	>18 patients	80.16 (16.84)	

t: Student-t test * $p < 0.05$, ** $p < 0.01$, Abbreviations: VSH: Vocational School of Health

The mean scores for the PES-NWI subscales were 2.40 (SD=0.44; range:1–3.78) for NPHA, 2.69 (SD=0.42; range:1–4) for NFQC, 2.55 (SD=0.53; range:1–4) for NMALSN, 2.16 (SD=0.61; range:1–4) for SRA and 2.58 (SD=0.57; range:1–4) for CNPR. Among these subscales, NFQC received the highest mean score (M=2.69, SD=0.42), while SRA was rated lowest (M=2.16, SD=0.61). Nurses' mean TPS score was 5.43 (SD=1.18; range:1–7), while mean NSNCS score was 82.42 (SD=18.60; range:20–100). Correlation analyses revealed no statistically significant correlations between nurses' mean scores on the PES-NWI subscales, TPS scores and NSNCS scores of patients ($p>0.05$) (Table 2).

Table 2. Descriptive findings and correlation matrix for measurement instruments.

	Mean (SD)	Min-Max	NPHA	NFQC	NMALS	SRA	CNPR	TPS	NSNCS
NPHA	2.40 (0.44)	1.00-3.78	1						
NFQC	2.69 (0.42)	1.00-4.00	0.705**	1					
NMALS	2.55 (0.53)	1.00-4.00	0.610**	0.521**	1				
SRA	2.16 (0.61)	1.00-4.00	0.492**	0.371**	0.379**	1			
CNPR	2.58 (0.57)	1.00-4.00	0.467**	0.458**	0.384**	0.287**	1		
TPS	5.43 (1.18)	1.00-7.00	0.038	0.049	-0.014	-0.058	0.055	1	
NSNCS	82.42 (18.60)	20-100	-0.051	-0.089	-0.010	0.077	-0.019	-0.032	1

r = Pearson correlation, * $p<0.05$, ** $p<0.001$, Abbreviations: “NPHA: Nurse Participation in Hospital Affairs, NFQC: Nursing Foundations for Quality of Care, NMALSN: Nurse Manager Ability, Leadership and Support of Nurses, SRA: Staffing and Resource Adequacy, CNPR: Collegial Nurse–Physician Relations, TPS: Task Performance Scale, NSNCS: Newcastle Satisfaction with Nursing Care Scale”

Discussion

This study examined the relationships between nurses' work environment characteristics, job performance and patients' satisfaction with nursing care. Overall, nurses' perception of their work environment, as measured using the PES-NWI, were slightly above average. These findings both align with and diverge from previous research, in which nursing work environments have been described as low¹⁸, moderate¹⁹, slightly above average^{20,21} or highly positive²². When the PES-NWI subscales were examined, the NFQC emerged as the highest-rated subscale, while the SRA received the lowest mean score. This pattern is consistent with previous studies reporting NFQC as the strongest and SRA as the weakest factor of the nursing work environment^{3,21}. However, van der Mark et al. reported more positive evaluations of staff and resource adequacy among nurses working in general wards²³.

Nurses' job performance scores were high in the present study, which is consistent with earlier findings reporting elevated levels of self-rated job performance^{15,24}. However, the

literature also includes evidence of moderate or lower levels of performance. For instance, Kalisch documented significant levels of missed nursing care, demonstrating that essential care activities were frequently delayed or omitted²⁵. These findings suggest that disruptions in nursing care processes may lead to moderate or lower levels of performance, which contrasts with the high performance reported in the present study. Similarly, Flynn et al. showed that unsupportive work environments negatively affect nursing care processes, resulting in increased pressure ulcers, missed care and nurse performance below expected standards²⁶. Together, these findings raise the possibility that nurses may overestimate their performance when assessed using self-report measures, particularly in settings where professional responsibility and self-efficacy are emphasized. Nurses may rate their task performance highly due to strong professional responsibility and self-efficacy beliefs, even under unfavorable working conditions.

Patients' satisfaction with nursing care was also found to be high, consistent with previous studies reporting generally high satisfaction levels^{27,28}. However, satisfaction is not uniformly high across contexts. Alasad and Ahmad, in a study conducted in Jordan, found that while patients evaluated nurses' technical competence positively, satisfaction was notably lower in areas related to communication, information sharing and emotional support²⁹. The high satisfaction observed in the present study aligns with some findings in the literature but contradicts others, suggesting that institutional culture, care organization and patient expectations may influence satisfaction with nursing care.

In this study, patients cared for by nurses working ≤ 45 hours per week, in units with a nurse-to-bed ratio of ≤ 2 and where nurses were responsible for ≤ 18 patients per shift reported significantly higher mean NSNCS scores. These findings suggest that patient satisfaction are sensitive to staffing levels and resource availability. Supporting this interpretation, Rosenbaum et al., in a two-period longitudinal study, demonstrated that improvements in nursing resources and work environments were strongly associated with increases in HCAHPS patient experience scores³⁰. Similarly, Li et al. reported that nurse burnout is negatively associated with patient safety, quality of care and patient satisfaction³¹. The findings of the present study highlight the importance of objective staffing indicators such as working hours, nurse-to-bed ratios and patient load in shaping patient satisfaction. Importantly, this study contributes to the literature by demonstrating that these resource-related factors may influence patient satisfaction even in the lack of direct relationship between overall work environment scores and patient satisfaction, emphasizing the need for targeted organizational investments in nursing workforce capacity.

Correlation analyses examining the relationships among nurses' work environment characteristics, job performance and patients' satisfaction with nursing care revealed no statistically significant correlations in this study. This finding contrasts with the literature reporting significant relationships between these variables. For instance, Alkhameeas et al. demonstrated that nurses working in environments with adequate staffing and resources perceived their job performance to be higher³². Other studies have reported significant relationships between the nursing work environment and outcomes

such as burnout, job satisfaction and turnover intention³³, as well as between work-related outcomes including motivation, job stress and coworker support³⁴. In addition, prior research suggests that the nursing work environment may indirectly influence patient satisfaction through performance-related components of care, such as nurse-patient communication, respect for patients, information sharing and continuous availability of care¹¹. Despite this evidence, no significant correlations were observed between PES-NWI, TPS and NSNCS scores in the present study. One possible explanation is the limited variability in key variables, as both nurses' self-reported task performance and patients' satisfaction levels were already high. Such ceiling effects may have reduced the statistical power to detect significant correlations. In addition, the study was conducted in only three public hospitals, where work environment characteristics, institutional structures and patient expectations were relatively similar. This contextual similarity may have further limited variability and prevented observable relationships between variables. Although these findings diverge from much of the literature, which generally reports positive relationships between work environment, performance and patient satisfaction, the present study contributes valuable insights by emphasizing the importance of contextual and sample-related factors.

Limitations and Further Research

Several limitations should be considered when interpreting the findings of this study. The research was conducted only in public hospitals located in Istanbul, which may restrict the applicability of the findings to different healthcare institutions or geographical settings. Second, nurses' job performance was assessed using self-reported measures, which may be influenced by subjective perceptions. Third, patients' satisfaction data were collected during hospitalization but before discharge; patients' post-discharge care assessments may differ. The results of the study should be evaluated within the context of this sample and the data collection tools used. Considering these limitations, future studies are encouraged to employ more comprehensive and diverse methodological approaches. Combining self-reported data with objective performance indicators and managerial assessments could provide a more accurate evaluation of nurses' job performance. In addition, assessing patient satisfaction both during hospitalization and after discharge would allow for comparative analyses and a deeper understanding of patients' care experiences.

Further research should also explore the relationships among nurses' job performance, work environment characteristics and patient satisfaction using larger and more heterogeneous samples. Comparative studies involving public and private healthcare institutions, as well as different provinces, regions and countries, are particularly recommended. Such studies would provide a more nuanced examination of how organizational context, resource availability and patient characteristics shape the complex interactions between the nursing work environment, performance outcomes and patient satisfaction.

Conclusion

This study examined the relationships among nurses' work environment characteristics, job performance and patients' satisfaction with nursing care, which is widely recognized as an important indicator of healthcare quality and has received increasing attention in health services research. The findings contribute to the existing literature by showing that relatively high levels of nurse-reported job performance and patient satisfaction can be observed even when perceptions of the work environment are only moderately possible. In addition, favorable outcomes in these areas may not necessarily correspond to statistically significant associations between the examined variables.

The study also identified several work-related characteristics of nurses associated with patients' satisfaction with nursing care. These findings may offer practical guidance for hospital administrators and nurse managers seeking to improve the quality of nursing services and patient experiences. Maintaining reasonable levels of weekly working hours, nurse-to-bed ratios and patient load per shift may help nurses allocate more time to direct patient care, which may in turn support higher patient satisfaction with nursing care.

Declarations

Ethics Approval and Consent to Participate: The research was conducted in accordance with the Declaration of Helsinki. Ethical approval for this study was obtained from the Istanbul University Social Sciences and Humanities Research Ethics Committee (Date: 05.11.2018, Number: 10). Permission was obtained via email from the authors of the Turkish-adapted scales. Written informed consent was obtained from all participants prior to data collection.

Competing Interests: The authors declare that they have no competing interests.

Funding: This research did not receive any specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Acknowledgements: The authors thank all nurses and patients who participated in the study.

REFERENCES

1. Donabedian A. The quality of care: How can it be assessed? *JAMA*. 1988;260(12):1743-8.
2. Lake ET. Development of the practice environment scale of the nursing work index. *Res Nurs Health*. 2002;25(3):176-88. doi: 10.1002/nur.10032.

3. Hong KJ, Lee Y. The moderating effect of nursing practice environment on the relationship between clinical nurses' sleep quality and wellness. *Int J Environ Res Public Health*. 2020;17(19):7068. doi: 10.3390/ijerph17197068.
4. Arslan Yürümezoğlu H, Sarioğlu E. The effects of nurses' work environment, working hours, and patient-to-nurse ratios on nurse outcomes: A comprehensive literature review. *J Health Nurs Manag*. 2022;9(1):153-67. doi: 10.54304/JHNM.2022.15367.
5. Sarıköse S, Göktepe N. Effects of nurses' individual, professional and work environment characteristics on job performance. *J Clin Nurs*. 2022;31(5-6):633-41.
6. AbuAlRub RF. Job stress, job performance, and social support among hospital nurses. *J Nurs Scholarsh*. 2004;36(1):73-8. doi: 10.1111/j.1547-5069.2004.04016.x.
7. Zhang J, Xu F, Wu J, et al. The effect of the nurse-patient relationship on the job performance of nurses in tertiary public hospitals in China: A cross-sectional survey. *BMC Health Serv Res*. 2025;25:812. doi: 10.1186/s12913-025-12850-2.
8. Akin T. Assessing quality of health care in the context of patient satisfaction from patients' perspective among a physical therapy and rehabilitation unit. *BMC Health Serv Res*. 2025;25:66. doi: 10.1186/s12913-025-12214-w.
9. Deriba BS, Geleta TA, Beyane RS, Mohammed A, Tesema M, Jemal K. Patient satisfaction and associated factors during COVID-19 pandemic in North Shoa health care facilities. *Patient Prefer Adherence*. 2020;14:1923-34. doi: 10.2147/PPA.S276254.
10. Guzmán-Leguel YM, Rodríguez-Lara SQ. Assessment of patients' quality of care in healthcare systems: A comprehensive narrative literature review. *Healthcare*. 2025;13(14):1714. doi: 10.3390/healthcare13141714.
11. Agostinho P, Potra T, Lucas P, Gaspar F. The nursing practice environment and patients' satisfaction with nursing care in a hospital context. *Healthcare*. 2023;11(13):1850.
12. Macnee CL, McCabe S. *Understanding Nursing Research: Reading and Using Research in Evidence-Based Practice*. 2nd ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2008.
13. Türkmen E, Badır A, Balcı S, Akkuş Topçu S. Turkish adaptation of the Nursing Work Index–Practice Environment Scale: A validity and reliability study. *J Nurs Res Dev*. 2011;13(2):5-20.

14. Goodman SA, Svyantek DJ. Person–organization fit and contextual performance: Do shared values matter? *J Vocat Behav.* 1999;55(2):254-75. doi: 10.1006/jvbe.1998.1682.
15. Kül S, Sönmez B. The effect of nurse managers' servant leadership on nurses' innovative behaviors and job performances. *Leadersh Organ Dev J.* 2021;42(8):1168-84.
16. Thomas LH, McColl E, Priest J, Bond S, Boys RJ. Newcastle satisfaction with nursing scales: An instrument for quality assessments of nursing care. *Qual Health Care.* 1996;5(2):67-72. doi: 10.1136/qshc.5.2.67.
17. Akin S, Erdogan S. The Turkish version of the Newcastle Satisfaction with Nursing Care Scale used on medical and surgical patients. *J Clin Nurs.* 2007;16(4):646-53.
18. Skela-Savič B, Sermeus W, Dello S, Squires A, Bahun M, Lobe B. How nurses' job characteristics affect their self-assessed work environment in hospitals: Slovenian use of the practice environment scale of the nursing work index. *BMC Nurs.* 2023;22(1):100.
19. Boev C. The relationship between nurses' perception of work environment and patient satisfaction in adult critical care. *J Nurs Scholarsh.* 2012;44(4):368-75.
20. Lake ET, Riman KA, Sloane DM. Improved work environments and staffing lead to less missed nursing care: A panel study. *J Nurs Manag.* 2020;28(8):2157-65.
21. Emiralioğlu R, Sönmez B. The relationship of nursing work environment and innovation support with nurses' innovative behaviours and outputs. *J Nurs Manag.* 2021;29(7):2132-41. doi: 10.1111/jonm.13349.
22. Liu Y, While A, Li SJ, Ye WQ. Job satisfaction and work-related variables in Chinese cardiac critical care nurses. *J Nurs Manag.* 2015;23(4):487-97. doi: 10.1111/jonm.12161.
23. Van der Mark C, Bitter J, Hendriks PHJ, Vermeulen H, van Oostveen CJ. The nurse perceived adequacy of staffing scale for general hospital wards: A development and psychometric validation study. *Int J Nurs Stud Adv.* 2023;5:100138.
24. Oweidat I, Abu Shosha G, Al-Harazneh R, et al. Nurses' perceptions of job security and performance: A comparative study between governmental and private hospitals. *PLoS One.* 2025;20(3):e0318412.
25. Kalisch BJ. Nurse and nurse assistant perceptions of missed nursing care: What does it tell us about teamwork? *J Nurs Adm.* 2009;39(11):485-93.

26. Flynn L, Liang Y, Dickson GL, Aiken LH. Effects of nursing practice environments on quality outcomes in nursing homes. *J Am Geriatr Soc*. 2010;58(12):2401-6.
27. Aiken LH, Sermeus W, McKee M, et al. Physician and nurse well-being, patient safety and recommendations for interventions: Cross-sectional survey in hospitals in six European countries. *BMJ Open*. 2024;14(2):e079931.
28. Boudreau C, Rhéaume A. Impact of the work environment on nurse outcomes: A mediation analysis. *West J Nurs Res*. 2024;46(3):210-8. doi: 10.1177/01939459241230369.
29. Alasad JA, Ahmad MM. Patients' satisfaction with nursing care in Jordan. *Int J Health Care Qual Assur*. 2003;16(6):279-85. doi: 10.1108/09526860310509276.
30. Rosenbaum KEF, Lasater KB, McHugh MD, Lake ET. Changes in patient care experiences and the nurse work environment: A longitudinal study of US hospitals. *Med Care Res Rev*. 2024;81(6):444-54. doi: 10.1177/10775587231197471.
31. Li LZ, Yang P, Singer SJ, Pfeffer J, Mathur MB, Shanafelt T. Nurse burnout and patient safety, satisfaction, and quality of care: A systematic review and meta-analysis. *JAMA Netw Open*. 2024;7(11):e2443059. doi: 10.1001/jamanetworkopen.2024.43059.
32. Alkhomeeas AA, Madani YA, Aldailej SA, et al. The impact of nurse staffing on patient outcomes: A comprehensive review. *Int J Innov Res Med Sci*. 2024;12(6):IJIRMP2406231491.
33. Dwinijanti L, Adhikara MF, Kusumapradja R. Job satisfaction and turnover intention among public sector nurses: Is workload and burnout the issue? *JEMA*. 2020;17(1):67-79.
34. Yeşilyurt T, Göktepe N, Türkmen E, Yalçın B. The relationship between nurses' individual, work-related variables, colleague solidarity, and work engagement: A cross-sectional study. *J Nursology*. 2023;26(4):246-52. doi: 10.5152/JANHS.2023.23547.

Classification of Ethical Dilemmas in Medical Social Work: A Conceptual Evaluation through Case Examples of Conflicting Values

Gizem ÇELİK ÖZKAN*

Abstract

This study categorizes ethical dilemmas encountered by social workers in the field of medical social work in thematic, contextual, and theoretical dimensions, focusing on confidentiality and information sharing, patient autonomy and beneficence, institutional pressures and resource limitations, and cultural/multidisciplinary tensions. Drawing on national and international literature, the article develops a conceptual framework for ethical dilemmas in medical social work, supports this framework with case examples and ethical decision-making models, and proposes a checklist to facilitate ethical decision-making from a perspective attentive to the Turkish context. This research highlights that ethical dilemmas are related to structural issues rather than individual deficiencies and proposes original research and application dimensions for the field.

Keywords: Medical social work, ethical dilemma, ethical decision-making.

Tıbbi Sosyal Hizmette Etik İkilemlerin Sınıflandırılması: Çatışan Değerler Arasında Vaka Örnekleri Üzerinden Kavramsal Bir Değerlendirme

Öz

Bu çalışmada, tıbbi sosyal hizmet alanında görev yapan sosyal hizmet uzmanlarının karşılaştığı etik ikilemler; tematik, bağlamsal ve kuramsal boyutlarda gizlilik-bilgi paylaşımı, hasta özerkliği-yarar sağlama, kurumsal baskılar-kaynak sınırlılığı ve kültürel/çok disiplinli gerilimler ekseninde sınıflandırılmıştır. Ulusal ve uluslararası literatür ışığında geliştirilen bu kavramsal çerçeve, vaka örnekleri ve etik karar alma modelleriyle desteklenmiştir. Türkiye bağlamına duyarlı bir perspektifle hazırlanan çalışmada, etik karar alma süreçlerini kolaylaştıracak kontrol listesi önerisi sunulmuştur. Çalışma, etik ikilemlerin bireysel yetersizlikten çok yapısal sorunlarla ilişkili olduğunu vurgulamakta ve alana yönelik özgün araştırma ve uygulama boyutları önermektedir.

Anahtar Sözcükler: Tıbbi sosyal hizmet, etik ikilem, etik karar alma.

Introduction

Health care services comprise a multilayered structure designed to improve quality of life and prevent life-threatening health issues. At the same time, they involve ethically

Derleme Makale (Review Article)

Geliş / Received: 15.10.2025 & **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1804497>

* Assoc. Prof. Dr., Bilecik Şeyh Edebali University, Faculty of Health Sciences, Department of Social Work, Bilecik, Türkiye. E-mail: gizem.celik@bilecik.edu.tr **ORCID** <https://orcid.org/0000-0001-6775-0525>

complex decision-making processes through the participation of different professional groups. A key component of this structure, medical social work, is defined as “the use of the approaches, methods, and techniques of the social work discipline to address the psychosocial and economic problems that cause illness or arise from illness”¹.

Medical social work can be considered an area of practice that involves not only biomedical issues but also complex psychosocial and ethical dimensions. The necessity of balancing patient needs with institutional policies often confronts medical social workers with complex ethical dilemmas.²

An ethical dilemma arises when two or more ethical principles come into conflict, making it difficult to determine the most appropriate course of action³. In the context of medical social work, these dilemmas often emerge around issues such as protecting the patient’s individuality (autonomy) versus considering family demands, maintaining confidentiality versus fulfilling reporting obligations, ensuring fair distribution of resources versus prioritizing those with the greatest need, and institutional policies versus professional ethics⁴⁻⁶. From a theoretical perspective, these dilemmas can be interpreted through multiple frameworks, including principlism (autonomy, beneficence, non-maleficence, and justice), ethics of care, and anti-oppressive social work practice. While principlism helps clarify tensions between competing ethical duties, care ethics emphasizes relational responsibility and contextual sensitivity, and anti-oppressive perspectives draw attention to institutional hierarchies and unequal access to resources.

While medical social work in Türkiye is an evolving field, systematic knowledge on ethical decision-making remains limited, and existing studies often address ethics across social work as a whole rather than focusing specifically on medical social work. International literature provides more focused discussions of ethical dilemmas encountered in hospital and health-care social work.

Although ethical dilemmas have been widely discussed in the social work literature, most studies address them at a general professional level rather than focusing specifically on medical social work practice. Moreover, existing studies often examine ethical dilemmas through isolated case analyses rather than proposing systematic classification frameworks. Particularly in the Turkish context, the literature remains fragmented and largely descriptive, limiting the development of integrative models that can guide ethical analysis in medical social work. This gap has practical consequences, as practitioners often navigate conflicts between professional ethics, institutional expectations, and patient rights without a structured conceptual reference. To address this gap, the present study proposes a four-axis conceptual framework that organizes recurring ethical dilemmas in medical social work and illustrates them through practice-oriented case examples.

Material and Methods

Study Design

This study utilizes a conceptual literature review to identify and categorize ethical dilemmas in medical social work. Rather than generating new empirical data, the study seeks to synthesize existing scholarly discussions and organize recurring ethical dilemmas into an analytically useful framework. Through this approach, the study aims to contribute to both the conceptual development of the field and practice-oriented ethical decision-making.

Data Sources

To ensure comprehensive coverage of the international and national literature, four academic databases were used: Web of Science, Scopus, DergiPark, and TRDizin. Web of Science and Scopus were selected because they index high-impact international publications in the fields of social work, health care, and medical ethics. DergiPark and TRDizin were included to capture studies published in Türkiye and to provide access to national academic discussions related to social work ethics.

Search Strategy

The literature search was initially conducted between 18-25 July 2025. In addition, a supplementary search was undertaken in the TRDizin database on 1 April 2026 in order to assess the extent of the national literature and to enhance the methodological transparency and reproducibility of the review. Different search strategies were applied across databases in accordance with their indexing systems. No overall date restriction was imposed in order to capture both foundational and contemporary discussions of ethical dilemmas in medical social work. The data collection process can be summarized as follows:

In the Web of Science database, the following search terms were used within the Topic field: “ethical dilemmas” OR “moral distress” OR “ethical issues” OR “ethical conflict” AND “medical social work” OR “hospital social workers” OR “health care social work” OR “social work in health care.” This search yielded 18 publications, of which 15 were considered directly relevant after detailed screening.

Relevant studies in the national literature were identified through a multi-stage search conducted in DergiPark and TRDizin. The initial search, conducted in DergiPark on 20 July 2025, used the title-based query “etik ikilem” OR “etik karar verme” OR “etik” AND “sosyal hizmet” OR “sosyal hizmetler.” With the publication year restricted to 2000-2025, this search retrieved 16,899 records. Because this broad strategy generated a substantial number of topically irrelevant results, a more focused keyword search was subsequently performed in DergiPark using “etik ikilem” AND “sosyal hizmet,” yielding four records. The initial broad DergiPark search was used for exploratory mapping of the national literature and was not treated as part of the final review corpus. Only studies

that met the relevance criteria after the focused search and subsequent content review were included in the analysis. To enhance methodological transparency and reproducibility, a supplementary advanced search was conducted in TRDizin on 1 April 2026. Using the “contains the exact word or phrase” option in the advanced search interface, the query “etik ikilem” AND “sosyal hizmet” was first applied to the abstract field, with language restricted to Turkish or English, and yielded seven records. The same query was then applied to the title field under the same language parameters, producing two additional records. These two title-based records were duplicates of studies already identified through the abstract search and were therefore excluded. Cross-database comparison indicated that three of the four studies retrieved through the focused DergiPark search were also identified in TRDizin. The remaining seven unique TRDizin records were subjected to detailed content review, and three studies were ultimately included in the analysis on the basis of their direct relevance to ethical dilemmas in social work practice.

In the Scopus database, the search was conducted in the title, abstract, and keywords fields using the following query: “ethical dilemmas” OR “moral distress” OR “ethical issues” OR “ethical conflict” AND “medical social work” OR “hospital social workers” OR “health care social work” OR “social work in health care.” This search identified 23 documents. After removing duplicates already indexed in Web of Science and excluding inaccessible full texts, one additional study (McCormick et al., 2014) was included in the analysis.

Inclusion and Exclusion Criteria

Studies were included if they addressed ethical dilemmas or ethical decision-making in social work practice, focused on medical, hospital, or health care social work contexts, provided conceptual discussion or empirical evidence concerning ethical conflicts in practice, and were published in Turkish or English. Studies were excluded if they focused on other professional groups without reference to social work practice, did not directly address ethical dilemmas, were confined to single-case analyses rather than broader conceptual or empirical discussion, duplicated records retrieved from other databases, or had inaccessible full texts.

A summary of the database searches and study selection process is presented in Table 1.

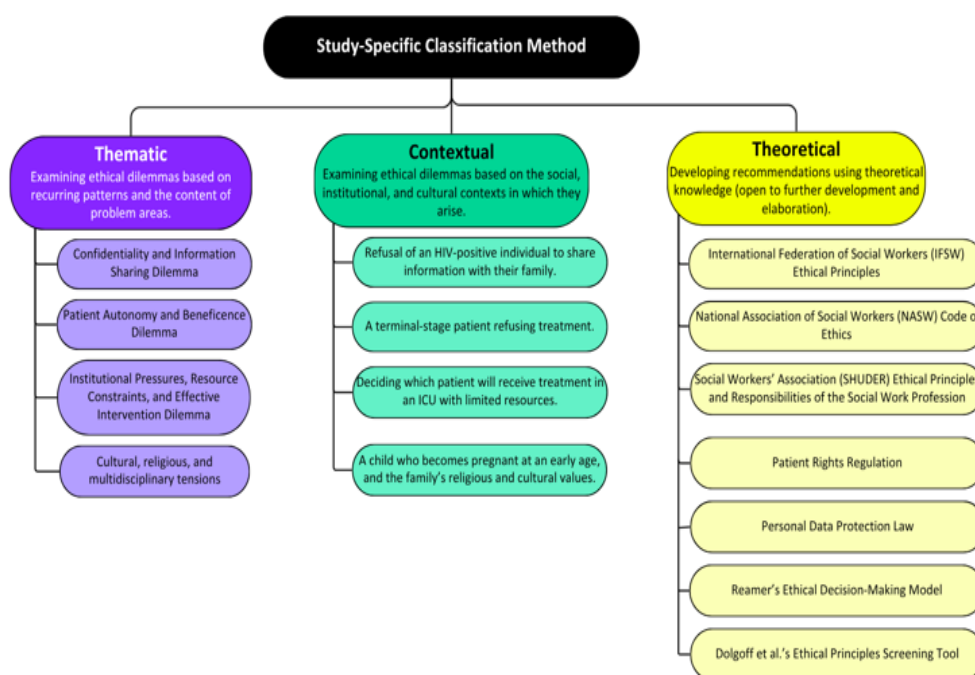
Table 1. Summary of database searches and study selection

Database	Search field / interface	Search query	Filters / limits	Records retrieved	Exclusion / screening outcome	Studies included
Web of Science	Topic	“ethical dilemmas” OR “moral distress” OR “ethical issues” OR “ethical conflict” AND “medical social work” OR “hospital social workers” OR “health care social work” OR “social work in health care”	None	18	After detailed screening, 15 records were considered directly relevant. Following detailed screening, three records were excluded due to lack of direct relevance to the topic	15
DergiPark	Title	“etik ikilem” OR “etik karar verme” OR “etik” AND “sosyal hizmet” OR “sosyal hizmetler”	Publication year: 2000-2025	16.899	Broad search produced a substantial number of topically irrelevant records	-
DergiPark	Keywords	“etik ikilem” AND “sosyal hizmet”	None	4	Three of the four records were also identified in TRDizin	-
TRDizin	Advanced search, abstract field; “contains the exact word or phrase”	“etik ikilem” AND “sosyal hizmet”	Language: Turkish or English	7	Retained for cross-database comparison and detailed content review	-
TRDizin	Advanced search, title field; “contains the exact word or phrase”	“etik ikilem” AND “sosyal hizmet”	Language: Turkish or English	2	Both records were duplicates of studies already identified through the abstract search and were excluded	-
TRDizin (final national sample)	Combined screened set	-	-	7	After detailed content review, 3 studies were found directly relevant to ethical dilemmas in social work practice	3
Scopus	Title, abstract, and keywords	“ethical dilemmas” OR “moral distress” OR “ethical issues” OR “ethical conflict” AND “medical social work” OR “hospital social workers” OR “health care social work” OR “social work in health care”	None	23	After duplicates already indexed in Web of Science were removed, one additional study was included in the analysis; four further studies were excluded due to lack of full-text access.	1

Analytical Approach and Development of the Classification Framework

The selected studies were examined to identify recurring ethical tensions reported in medical social work practice. Particular attention was given to situations in which professional values, institutional expectations, and client rights came into conflict. Through repetitive comparison of themes across the reviewed literature, several recurring patterns of ethical conflict were observed. These patterns were then conceptually grouped and refined into broader analytical categories. The dilemmas were also examined through contextual case examples reflecting the social, institutional, and cultural settings in which they arise (see Figure 1). This thematic synthesis identified four principal axes of ethical dilemmas: confidentiality, autonomy, institutional pressures, and cultural and multidisciplinary tensions.

Figure 1. Conceptual classification of ethical dilemmas in medical social work developed through literature review and thematic analysis (created by the author).



These axes reflect both core principles of medical ethics and structural conditions shaping social work practice within health care institutions. While these categories are analytically separated for conceptual clarity, ethical dilemmas encountered in practice often overlap and interact with each other. The characteristics of the included studies and their relationship to the four analytical axes are presented in Table 2.

Table 2. Characteristics of the included studies, the ethical dilemmas addressed, and their relation to the analytical framework

No	Authors of Study	Source Database	Type of Ethical Dilemma(s) Addressed	Related Analytical Axis	Additional Notes
1	Fantus et al. (2017) ²	WoS	Clinical situations (confidentiality, autonomy); working conditions; structural constraints; moral resources	Patient autonomy/beneficence; institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Oncology or terminal care patients; detailed discussion of moral distress
2	Csikai (2000) ⁴	WoS	Autonomy; quality-of-life enhancement	Patient autonomy/beneficence; cultural, religious, and multidisciplinary tensions	Interviews with 122 social workers on euthanasia and assisted suicide
3	Landau (2001) ⁵	WoS	Limited resources; technological interventions; information asymmetry; time pressure	Institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Interviews with 32 social workers
4	Proctor et al. (1993) ⁶	WoS	Autonomy vs. best interests; loyalty to colleagues vs. patient welfare; institutional priorities vs. patient needs	Patient autonomy/beneficence; institutional pressures/resource limitations	Highlights the recurrent tension between self-determination and beneficence in health care
5	Cummings and Cockerham (1997) ¹⁵	WoS	Autonomy; beneficence; justice	Patient autonomy/beneficence; institutional pressures/resource limitations	Patients with Alzheimer's disease
6	Csikai et al. (2004) ¹⁶	WoS	Patient autonomy/self-determination vs. family pressure; truth-telling; beneficence; non-maleficence; justice; acceptance; surrogate decision-making	Patient autonomy/beneficence; cultural, religious, and multidisciplinary tensions	12 social workers in oncology; includes practice recommendations
7	Fantus and Cole (2022) ¹⁷	WoS	Clinical situations (end-of-life decisions, patient autonomy); working conditions (lack of team transparency, delayed or incorrect consultation, supervision problems); structural conditions (insurance barriers, resource scarcity, hospital policy); moral resources (devaluing hierarchy, promotion pressure)	Patient autonomy/beneficence; institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Further elaboration on moral distress
8	Jones and Egan (2000) ¹⁸	WoS	Fair organ allocation; informed consent/autonomy; marginalization of the social work role; economic vulnerability	Patient autonomy/beneficence; institutional pressures/resource limitations	Longitudinal interviews with 20 liver transplant recipients (6 weeks, 6 months, 12 months)
9	Winnett (2022) ¹⁹	WoS	Moral distress (patient distrust and anger, systemic poor practice, discharge pressure); emotional burden; judgement and ambivalence	Institutional pressures/resource limitations	Hospital social workers working with people experiencing homelessness
10	Albrithen and Dziegielewska (2016) ²⁰	WoS	Cultural taboos; procedural constraints; differences in professional competence	Institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	218 hospital social workers in Saudi Arabia; cultural sensitivity; supervised supervision; local interpretations of universal principles
11	Kesen et al. (2021) ²¹	WoS	Dual relationships; client threats; transfer of personal values into practice; child custody issues;	Confidentiality and information-sharing; patient autonomy/beneficence;	Study with 227 social workers from multiple fields in Türkiye

			misuse of state benefits; tension between legal regulations and humanitarian values; political and administrative pressures; confidentiality; autonomy vs. protection	institutional pressures/resource limitations	
12	Lewinson et al. (2023) ²²	WoS	Resource scarcity; expanded roles and responsibilities; conflicting institutional policies; feelings of being unprotected, overburdened, and undervalued; fatigue; somatic symptoms; loneliness; fear	Institutional pressures/resource limitations	Psychological distress among hospital social workers during the pandemic
13	Solmaz and Artan (2023) ²³	DergiPark/ TRDizin	Professional roles vs. institutional roles; autonomy, access to information, and decision-making vs. client safety; confidentiality vs. non-maleficence; scarce resources vs. equitable service provision; cultural values vs. universal ethical principles	Confidentiality and information-sharing; patient autonomy/beneficence; institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Qualitative study with 15 social workers from different fields; ethical dilemmas reported in all cases
14	Taş and Karataş (2024) ²⁴	DergiPark/ TRDizin	Breach of confidentiality and erosion of trust; administrative and political pressure; ambiguity of legal criteria; withholding of information by clients; cultural hospitality vs. ethical rules; collecting information through social media; prejudice toward clients; service insufficiency; judgemental attitudes; privacy violations in home visits; sharing service-delivery photographs	Confidentiality and information-sharing; institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Ethical issues in social assistance and need-assessment practice
15	Walsh-Bowers et al. (1996) ²⁵	WoS	Conflicting supervisory directives; weakening of confidentiality through information sharing between medical social workers and physicians without written consent	Confidentiality and information-sharing; institutional pressures/resource limitations; cultural, religious, and multidisciplinary tensions	Suggests that mental health professionals perceive more ethical dilemmas in organizational processes
16	McCormick et al. (2014) ²⁷	Scopus	Informed consent; decisional capacity; assessment of decisional capacity; cultural influences on decision-making	Cultural, religious, and multidisciplinary tensions	350-bed trauma center; 100 social workers; ethical decision-making standards: autonomous patient choice, substituted judgement, best interests
17	Pugh (2015) ²⁸	WoS	Professional independence; relationships with multidisciplinary teams	Cultural, religious, and multidisciplinary tensions	Strong association between ethical climate and job satisfaction; organizational support and ethics resources are emphasized
18	Rasoal et al. (2016) ²⁹	WoS	Powerlessness in interactions with patients and relatives; discomfort with unsafe and inequitable care; uncertainty regarding decision-making authority	Cultural, religious, and multidisciplinary tensions	Includes unmet emotional needs, challenges in ensuring fair care, and uncertainty regarding autonomy and information sharing
19	Dursun et al. (2022) ³⁰	DergiPark/ TRDizin	Practices contrary to dignity and worth of the person; discrimination; breaches of confidentiality and privacy; conflict between client wishes and legal regulations; decision conflicts in cases involving abuse, violence, and false statements	Cultural, religious, and multidisciplinary tensions	171 social workers from multiple fields; low attitudes toward ethical dilemmas; significant differences by field of practice

Case Examples

The case examples presented in the study are hypothetical scenarios developed based on patterns of ethical dilemmas described in the literature. They are intended to illustrate typical ethical conflicts encountered in medical social work practice and to demonstrate how ethical decision-making may unfold in such situations. The cases do not represent real individuals and are used solely for analytical and educational purposes. The resolution of the ethical dilemmas presented in the case examples was grounded in the systematic ethical decision-making frameworks developed by Reamer (2006) and Dolgoff and colleagues (2005).

Ethical Dilemma and the Ethical Decision-Making Process

An ethical dilemma is defined as “a situation that cannot be resolved in an ethically acceptable way, where a choice must be made between at least two options”⁷. Because each option carries positive and negative consequences, choosing the most appropriate course of action may impose a substantial cognitive and emotional burden.

Although ethical dilemmas are often defined as conflicts between professional duties and obligations⁸, their causes and consequences frequently involve broader values such as human rights, the right to health, the right to life, and individual autonomy. When these conflicts remain unresolved, they may contribute to moral distress, job dissatisfaction, turnover intentions, and weakened ethical decision-making capacity among practitioners. Furthermore, this process can create a negative cycle, leading to a decline in psychological resilience and a weakening of ethical decision-making skills⁹. In some cases, however, confronting ethical dilemmas may also strengthen ethical sensitivity and professional awareness².

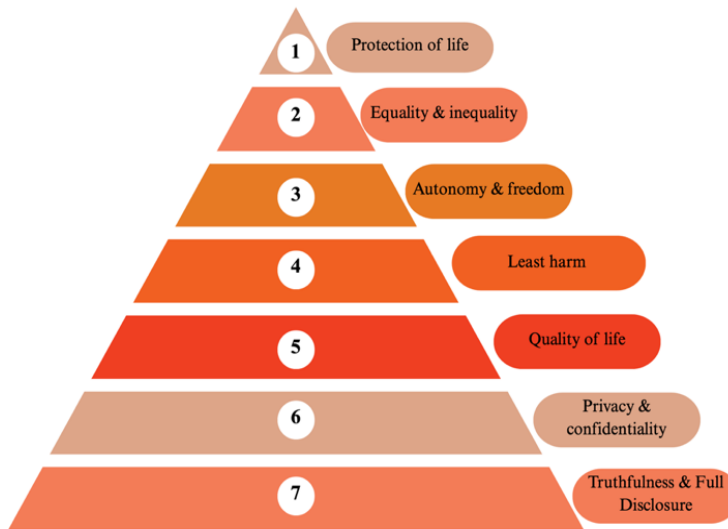
Brill (2001) argues that social workers increasingly need ethical decision-making models because they practice in more complex environments, face a growing number of ethical dilemmas, and often work with limited resources¹⁰. Various theoretical models have been developed in the social work literature for identifying and managing ethical dilemmas. One of these, the “Ethical Decision-Making Model”³ states that the following stages should be followed in the decision-making process;

a) Defining the ethical problem or dilemma, b) Identifying all affected parties, c) Analyzing the potential benefits and risks of relevant ethical principles and values for the parties, d) Thoroughly examining the reasons for and against each action option, e) Determining the option that will provide the most benefit with the least harm and documenting the decision-making process and f) Monitoring, evaluating the decision, and documenting the process.

Another important approach is the model developed by Dolgoff, Loewenberg, and Harrington (2005), which follows processes similar to Reamer's model and can be used for many different situations⁸. Dolgoff and colleagues (2005) also developed the Ethical Principles Screen, a tool that functions as a hierarchy of ethical principles to guide

practitioners in prioritizing conflicting principles. For example, in this model, the preservation of life is considered a higher priority than privacy and confidentiality¹¹ (see Figure 2).

Figure 2. Hierarchy of ethical principles.



Source: Dolgoff, Loewenberg and Harrington (2005).

While such models facilitate a more systematic approach to ethical decision-making, each case should still be evaluated within its own social, cultural, and institutional context. The ethical dilemmas encountered in medical social work also resonate with dilemmas observed in other areas of social work practice.

Types of Ethical Dilemmas in Medical Social Work

Like other areas of social work practice, medical social work involves various ethical dilemmas. Based on the conceptual analysis of the reviewed literature, a classified analysis of the types of ethical dilemmas encountered in medical social work is presented (see Figure 1).

The Confidentiality and Information-Sharing Dilemma

In social work, confidentiality refers to the protection of private information about the client within the professional relationship. However, this right is not absolute; in certain circumstances, information can legitimately be shared with relevant individuals or institutions¹². In the Ethical Principles Screen developed by Dolgoff and colleagues (2005), confidentiality ranks below five other principles¹¹. This situation demonstrates that although confidentiality is a fundamental ethical principle, it can become secondary when it conflicts with other values. A commonly encountered ethical dilemma in this area can be illustrated with the following case:

“Ahmet, a 30-year-old single man, has recently been diagnosed as HIV-positive. The diagnosis was made through regular blood tests, and he has been informed. Ahmet wishes to keep his diagnosis confidential from both his family and his fiancée. The hospital social worker holds confidential meetings with Ahmet. However, the Sexually and Bloodborne Transmitted Diseases Unit recommends informing the family and fiancée. The practitioner encounters a conflict between protecting Ahmet’s right to privacy and decision-making autonomy and mitigating potential health risks to third parties, including his family and fiancée”.

Social workers must prioritize confidentiality, but sharing information may be considered if there is a risk of serious harm. Reamer (2006) emphasizes that sharing information without the client's consent in similar situations can be unethical. However, in this case example, the ethical dilemma is not limited to the client's rights³. Navigating the tension between confidentiality and information sharing requires a structured ethical decision-making approach. Possible approaches may include discussing safe practices with the client, explaining risk-reduction measures, seeking advice from the hospital’s ethics committee, and, if necessary, sharing information with the team in an anonymized form. This dilemma also reflects the broader tension between protecting individual privacy rights and meeting institutional demands for coordination, risk management, and multidisciplinary accountability. In summary, resolving confidentiality and information-sharing dilemmas requires active institutional ethics committees, ethics supervision for health professionals, clear protocols on confidentiality and its exceptions, and stronger legal awareness among practitioners.

The Patient Autonomy and Beneficence Dilemma

One of the core principles of medical ethics is “Beneficence and Non-maleficence”, which prioritizes acting in the patient’s best interest, avoiding harm, and balancing risks and benefits¹². Autonomy refers to the individual’s right to make decisions without external pressure, using their own reasoning abilities, and to determine the boundaries of their self-determination¹³. From a theoretical perspective, this tension illustrates the recurring conflict between respect for self-determination and professional responsibility to prevent foreseeable harm. Social work ethics, both nationally and internationally, emphasize the client’s right to self-determination, requiring social workers to respect and support this right¹⁴. Thompson (2013) emphasizes, stating that the right to autonomy does not mean that social workers will accept all client actions and choices without limitation¹². Ethical dilemmas often arise between these two principles, particularly in cases involving cognitive impairment, end-of-life decision-making, and family involvement⁶. Examples in the literature include patients with Alzheimer’s disease¹⁵, requests for euthanasia or assisted suicide⁴, patients in oncology or terminal care^{2,16,17}, and organ transplant recipients¹⁸. A case example illustrates this tension:

“Ayşe, a 58-year-old patient with metastatic pancreatic cancer, is receiving palliative care in the oncology unit, and her quality of life is declining. Ayşe expresses her wish to spend the rest of her life at home and to refuse any further chemotherapy. Her husband and

children insist that she should continue fighting. The physician, uncertain about the ethical implications, seeks support from the social worker.”

The ethical dilemma in this case lies between the social worker’s duty to respect the client’s autonomous decision regarding the final period of her life and the duty to provide benefit by considering medical necessity and the family’s wishes. Ayşe wishes to end painful and hopeless treatment processes and to make her own choice about the last days of her life. This is a fundamental patient right. However, the health team wants to apply medical interventions that could extend life, even if only for a short time. Possible interventions and solutions may include: confirming that Ayşe is making her decision knowingly and with adequate capacity to understand; holding group sessions with family members to explain the meaning of respecting the patient’s autonomy and right to life; coordinating with the palliative care team to create a care plan focused on pain and comfort rather than medical interventions; and, if the decision-making process becomes blocked, involving the ethics committee to provide institutional support for the decision.

Institutional Pressures, Resource Limitations, and the Ethical Dilemma of Effective Intervention

Hospitals are institutional environments characterized by fast-paced, multidisciplinary, and hierarchical structures. As in all institutions, health care organizations operate with limited resources. Integrating social work values such as human rights and equality can conflict with restrictive institutional structures and policies^{2,5,6,13,15,17-25}.

Social workers, based on their education and professional ethics, aim to provide the most beneficial interventions for the patient with the most appropriate resources. However, hospital policies and regulations often prioritize criteria such as time, cost, procedure, or “efficiency,” which may leave social workers’ professional requests unmet. Akkuş (2021) notes that the uncritical adoption of a cost- and efficiency-based neoliberal organizational culture weakens professionals’ sense of responsibility, and in Türkiye, the prevalence of short-term contracts, minimum-wage employment, and work across multiple institutions makes ethical practice nearly impossible²⁶. Ethical dilemmas related to institutional pressure and resource constraints include the allocation of scarce health resources according to equality and need¹⁵, limited access to social assistance for patients who cannot afford costly medication¹⁸, restricted service provision for certain groups such as people experiencing homelessness¹⁹, and the inability to provide optimal care because of staff shortages, hierarchical structures, weak interprofessional interaction², information asymmetry, time pressure⁵, poor team transparency, delayed consultation, supervision problems, insurance barriers, and the devaluation of social work expertise¹⁷. Rather than being merely administrative barriers, such constraints reveal how structural inequalities and policy priorities shape ethical practice opportunities.

In their research, Kesen and colleagues (2021) concluded that social workers who faced the risk of being unable to make fair decisions due to political or administrative pressure often ended up resigning²¹. The erosion of professional independence among

professionals due to political and administrative pressure has also been noted by Taş and Karataş (2024)²⁴. It has even been noted that professionals may face ethical issues due to theoretical approaches that encourage sharing practice photos on social media in exchange for services provided to clients. A representative case illustrates the nature of this dilemma:

“In the hospital's intensive care unit, two patients are waiting for a single available ventilator: Mehmet, an 82-year-old patient with multiple organ failure, and Ali, a 25-year-old patient who was severely injured in a car accident. Because the medical team believes the younger patient has a higher chance of recovery, they consider transferring Mehmet to the palliative care unit. However, Mehmet’s family strongly opposes this decision and asks the social worker to intervene”.

In this case, the ethical dilemma arises from pressure by hospital administration to have the social worker ‘convince the family’ in line with bed-turnover policies, while the social worker remains responsible for defending the older patient’s rights and participating in an ethical evaluation of resource allocation aimed at saving the younger patient’s life. Fair distribution of medical resources and the establishment of distribution committees are among the core principles of medical ethics¹³, and both equality and need should guide decisions regarding who receives care¹⁵. In this dimension, which is evaluated within the framework of the principle of social justice, one of the important ethical values of social work, the social worker may need to present their professional assessment in collaboration with the physician and ethics committee to ensure a fair decision is made regarding who will prioritize limited intensive care resources. In this context, while providing a ventilator to a young patient would be beneficial, discharging an elderly patient would pose a risk. This approach enables the decision to emerge from multidisciplinary deliberation rather than from unilateral institutional pressure. Effective implementation requires conveying the consensus-based decisions to the family through transparent and empathetic communication. In the event that Mehmet is removed from the intensive care unit based on this shared decision, alternative resources and services (the status of the intensive care units in neighboring hospitals, the possibilities offered by the palliative care unit, etc.) should be explored and presented to the family as options.

Cultural, Religious, and Multidisciplinary Tensions

In addition to confidentiality, autonomy, and institutional pressures, the review identified a fourth analytical axis consisting of ethical tensions arising in multidisciplinary collaboration and in conflicts between cultural or religious values and professional ethics. This axis captures dilemmas that emerge when social workers must negotiate role boundaries within health-care teams, respond to culturally mediated expectations, and uphold universal professional principles in contexts shaped by local norms, legal constraints, and institutional hierarchies. Relevant studies indicate that these tensions become particularly visible in end-of-life care, taboo or criminalized issues, interprofessional disagreement, uncertainty regarding decision-making authority, and contexts in which social workers’ professional judgements are

marginalized within team processes^{2,4-5,16-20,23-25,27-29}. These cases demonstrate that ethical dilemmas are often relational and context-dependent, requiring culturally responsive and interdisciplinary judgement rather than relying solely on fixed procedural rules.

Landau (2001) found that ethical decision-making in hospitals is inherently interdisciplinary and that the contribution of social work is shaped by intra-team competition, individual differences, type of service unit, and the nature of the ethical dilemma⁵. While theoretical models of ethical decision-making in social work exist, empirical studies focusing on hospital practice remain limited, and the role of social work in multidisciplinary ethical decision-making is not clearly defined.

Fantus and colleagues (2017) observed that social workers often tend to remain silent when they encounter situations in which they should intervene but are prevented from doing so². This emotional conflict contributes to physical and psychological burnout. At this point, social workers' professional competence and their capacity to act decisively in ethical decision-making may be called into question. For example, in a study conducted by Dursun et al. (2022), it is recommended that the supervision system be strengthened, the ethical dimension be integrated and updated in all courses, and case study-based ethics training be provided integrated with the field³⁰. Albrithen and Dziegielewska (2016) highlighted the relative newness of social work in Saudi Arabia, the difficulty of directly transferring Western norms, and the need for culturally sensitive local interpretations of universal ethical principles²¹. Similarly, Solmaz and Artan (2023) found conflicts between cultural values and universal ethical principles across various practice areas²³.

Ethical dilemmas involving cultural and religious values often emerge in contexts where certain issues are considered taboo (e.g., abortion, gender transition) or are legally defined as crimes (e.g., early-age pregnancy, abuse, violence), as well as in areas where some practices are not legally defined in certain countries (e.g., euthanasia or assisted dying). For instance, in Türkiye, a 15-year-old girl became pregnant as a result of child marriage, and her family defended the situation as 'religiously legitimate' and socially normal. The social worker, however, was obligated to intervene in line with universal ethical principles (the best interest and protection of the child) and legal regulations. In such situations, the social worker faces a serious ethical dilemma between protecting the client's rights and welfare and respecting family and community values. In some cases, these conflicts can escalate to threats to the social worker's personal safety³¹. To manage such dilemmas effectively, social workers need not only individual ethical sensitivity but also access to ethical supervision mechanisms and training in cultural competence. Regular case review meetings within multidisciplinary teams and the active functioning of hospital ethics committees can provide more transparent and collective platforms for addressing these conflicts.

Conclusion

This study contributes to the literature on medical social work ethics by proposing a four-axis conceptual framework that organizes ethical dilemmas encountered in health care settings. Interpreted through principlism, ethics of care, and anti-oppressive social work perspectives, this framework clarifies how ethical dilemmas emerge across personal, professional, and structural domains. By synthesizing dispersed discussions in the literature and linking them to practice-oriented case examples, the study provides a structured perspective for understanding recurring ethical conflicts in medical social work practice. It should be understood as a heuristic model that may guide education, supervision, and future empirical validation studies. The conceptual literature review revealed that studies on ethical issues in the national literature are limited and that none directly address the field of medical social work. Beyond individual or professional inadequacy, this study identifies fragmented legislation and resource scarcity as the primary drivers of ethical dilemmas.

The reviewed literature suggests that ethical dilemmas constitute a recurrent component of medical social work practice, but it does not support firm comparisons with all other fields of social work. Within this scope, the proposed ethical decision checklist should be read as a conceptual and practice-oriented aid derived from Reamer (2006) and Dolgoff et al. (2005), not as an empirically validated instrument. Its primary value lies in structuring ethical deliberation, documenting competing duties, and making professional reasoning more transparent in complex cases. Future empirical research should assess its usability, acceptability, and institutional applicability in different health-care settings before any stronger claims are made about its effectiveness.

Figure 3. Conceptual illustration of an ethical decision checklist for medical social work (created by the author).

ETHICAL DECISION CHECKLIST (Medical Social Work)

Document Code: EDCL-MSW v1.0 (21.08.2025)

Scope: All clinical social work interventions, discharge processes, high-risk cases

A. Case Summary

☐ Case/Incident Title: _____

☐ Date/Time: ____/____/____

☐ Unit(s): _____

☐ Responsible Social Worker: _____

B. Parties and Stakeholders

☐ Client(s) / relative(s): _____

☐ Health team (physician, nurse, MSW, etc.): _____

☐ Institutional management / medical social work unit: _____

☐ External stakeholders (Family Health Center, municipality, judicial/child protection, etc.): _____

C. Information and Evidence Status

☐ Medical data (current): _____

☐ Psychosocial assessment: _____

☐ Risk indicators (violence, abuse, suicide, neglect, homelessness, poverty, infectious disease, etc.): _____

☐ Missing information/uncertainty: _____

D. Legislation and Policy Cross-Check

☐ Institutional protocol (code: _____)

☐ Patient Rights / GDPR / Reporting obligations: _____

☐ MSW Implementation Directive / other instructions: _____

E. Prioritization of Ethical Principles

☐ 1) Protection of life

☐ 2) Equality / inequality

☐ 3) Autonomy / freedom

☐ 4) Least harm

☐ 5) Quality of life

☐ 6) Privacy / confidentiality

☐ 7) Truthfulness / Full Disclosure

F. Risk-Benefit Analysis

Severity: ☐ Low ☐ Moderate ☐ High ☐ Very High

Probability: ☐ Low ☐ Moderate ☐ High

Red Flag: ☐ Immediate Serious Harm ☐ Child/Dependent ☐ Legal Case

G. Set of Options and Their Impacts

Option A: _____ / Benefit: _____ / Harm: _____

Option B: _____ / Benefit: _____ / Harm: _____

Option C: _____ / Benefit: _____ / Harm: _____

H. Consent, Capacity, and Communication

☐ Decision-making capacity assessed (yes/no/uncertain): _____

☐ Informed consent obtained / not obtained (justification: _____).

☐ Family/meeting conducted and documented: _____

☐ Interpreter used (if needed): _____

Page 1

I. Consultation Mechanisms

☐ Ethics committee (urgent/planned): _____

☐ Legal / risk management: _____

☐ Palliative / psychiatry / infectious diseases / medical social work unit: _____

J. Confidentiality and Data Sharing

☐ The principle of "purpose-limited" information sharing was applied.

Shared data: _____

Recipient: _____

Legal basis: _____

K. Decision and Rationale (brief)

Option: _____

Ethical basis (prioritized principles): _____

Regulation/policy compliance: _____

Expected benefits/risks: _____

L. Implementation and Follow-Up

Responsible person(s): _____

Timeline: _____

Follow-up date: ____/____/____

Feedback/reassessment condition: _____

Signature

Responsible MSW: _____ Team Leader: _____ Ethics Representative: _____

Date/Time: ____/____/____ * _____

M. Stop Criteria

☐ Immediate serious harm / child protection / legal reporting → IMMEDIATE

Page 2

Note: This form has been designed based on theoretical knowledge to serve as a checklist for guiding the steps to be followed when ethical dilemmas arise.

Figure 3 presents the checklist as a conceptual illustration intended to support reflection, documentation, and transparent ethical reasoning in complex cases. Its usability and institutional applicability should be examined through future field-based research. Given the moral distress experienced by practitioners in ethically complex situations, ethical decision-making should be addressed not only as an individual professional responsibility but also as an institutional support issue. To strengthen ethical practice in

medical social work, institutions should promote regular ethics training, ethical supervision, multidisciplinary case review meetings, and support mechanisms for moral distress^{2,13,23}. Social work education programs may also integrate case-based ethical simulations, cultural competence training, and strategies for coping with moral distress²⁷. Future University-Ministry-Field partnerships may help translate these initiatives into sustainable institutional and policy arrangements.

This study has certain limitations. First, as a conceptual review, the article synthesizes the existing empirical literature on ethical dilemmas in medical social work but does not generate original empirical findings. Second, literature retrieval was limited to Web of Science, Scopus, DergiPark, and TR Dizin and therefore did not include potentially relevant internal institutional reports. In addition, because the framework was derived through conceptual synthesis rather than formal qualitative coding with inter-rater validation, the allocation of some studies to a single analytical axis should be interpreted as heuristic rather than definitive. Finally, the four-axis structure of the conceptual framework may have led to the misconception that dilemmas, which in practice become increasingly intertwined and complex, can sometimes be reduced to a single axis.

These limitations also point to several directions for future research. These include: 1) Quantitative, qualitative, or mixed-model studies on the ethical dilemmas experienced by medical social work professionals in Türkiye, their types, the frequency of these ethical incidents, and ethical decision-making processes, 2) Intervention and experimental studies measuring the improved well-being and work performance of patients and social workers through structured support mechanisms and ethics counseling systems for moral distress.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

Financial Disclosure: The author declared that this study has no financial support.

Ethical Approval: This study was conducted using publicly available data obtained from the Web of Science, DergiPark, TR Dizin, Scopus database. As the study did not involve human or animal participants, ethical approval was not required.

REFERENCES

1. Özbesler C. Hasta yaşam kalitesinde tıbbi sosyal hizmet uygulamalarının önemi. *Tıbbi Sosyal Hizmet Dergisi*. 2013;(2):6-12.
2. Fantus S, Greenberg RA, Muskat B, Katz D. Exploring moral distress for hospital social workers. *Br J Soc Work*. 2017;47(8):2273-2290. doi: 10.1093/bjsw/bcw113.
3. Reamer FG. *Ethics and Values in Social Work*. 3rd ed. New York, NY: Columbia University Press; 2006.

4. Csikai EL. Hospital social workers' attitudes toward euthanasia and assisted suicide. *Soc Work Health Care*. 2000;30(1):51-73. doi: 10.1300/J010v30n01_04.
5. Landau R. Ethical dilemmas in general hospitals: Social workers' contribution to ethical decision-making. *Soc Work Health Care*. 2001;32(2):75-92. doi: 10.1300/J010v32n02_05.
6. Proctor EK, Morrow-Howell N, Lott CL. Classification and correlates of ethical dilemmas in hospital social work. *Soc Work*. 1993;38(2):166-177.
7. Banks S. *Ethics and Values in Social Work*. 4th ed. Basingstoke, UK: Palgrave Macmillan; 2012.
8. Gökçearslan Çifci E, Gönen E. Sosyal hizmet uygulamalarında etik karar verme süreci. *Toplum ve Sosyal Hizmet*. 2011;22(2):149-160.
9. Erkoç B, Lotfi S. Sosyal hizmet öğrencilerinin psikolojik sağlık düzeylerinin etik ikilem karşısında tutumlarına etkisinin tespit edilmesine yönelik bir araştırma. *J High Educ Sci*. 2021;11(2):411-416. doi: 10.5961/jhes.2021.460.
10. Brill CK. Looking at the social work profession through the eye of the NASW Code of Ethics. *Res Soc Work Pract*. 2001;11(2):223-234. doi: 10.1177/104973150101100209.
11. Dolgoff R, Loewenberg F, Harrington D. *Ethical Decisions for Social Work Practice*. 7th ed. Belmont, CA: Brooks/Cole-Thomson Learning; 2005.
12. Thompson N. *Kuram ve Uygulamada Sosyal Hizmeti Anlamak*. Özlem Cankurtaran-Öntaş, Burcu Hatipoğlu Eren, eds. Ankara: Dipnot Yayınları; 2013.
13. Bilgin R, Küçükazar M. Türkiye'de kamu sağlık kuruluşlarında yaşanan etik dışı davranışlar ve uygulamaların genel görünümü. *Munzur Univ Sos Bilim Derg*. 2018;7(13):119-140.
14. Sosyal Hizmet Uzmanları Derneği (SHUDER). *Sosyal Hizmet Mesleğinin Etik İlkeleri ve Sorumlulukları*. Ankara: Evin Yayıncılık; 2004.
15. Cummings SM, Cockerham C. Ethical dilemmas in discharge planning for patients with Alzheimer's disease. *Health Soc Work*. 1997;22(2):101-108. doi: 10.1093/hsw/22.2.101.
16. Csikai EL, Roth S, Moore C. Ethical problems in end-of-life care decision making faced by oncology social workers and the need for practice guidelines. *J Psychosoc Oncol*. 2004;22(1):1-18. doi: 10.1300/J077v22n01_01.
17. Fantus S, Cole R, Hawkins L. "The hierarchy is your constraint:" A qualitative investigation of social workers' moral distress across a U.S. health system. *Soc*

Work Health Care. 2022;61(6-8):387-411. doi:
10.1080/00981389.2022.2128156.

18. Jones JB, Egan M. The transplant experience of liver recipients: Ethical issues and practice implications. *Soc Work Health Care*. 2000;31(2):65-88. doi: 10.1300/J010v31n02_06.
19. Winnett R. The experiences of hospital social workers who care for homeless patients: An interpretive phenomenological analysis. *Soc Work Health Care*. 2022;61(1):52-68. doi: 10.1080/00981389.2022.2033379.
20. Albrithen A, Dziegielewska SF. Practicing social work ethics among hospital social workers in Saudi Arabia. *J Soc Serv Res*. 2016;42(5):729-741.
21. Kesen NF, Başer D, Daşbaş S, Dziegielewska SF. Ethical difficulties among Turkish social workers. *J Soc Serv Res*. 2021;47(5):681-693. doi: 10.1080/01488376.2021.1889736.
22. Lewinson TD, Washington TR, Allen SE, Murphey JM, Onsando WM. “We’re kind of on the back burner”: Psychological distress and coping among medical social workers during the COVID-19 pandemic. *Soc Work Health Care*. 2023;62(6-7):243-262.
23. Solmaz U, Artan DDT. Türkiye’de farklı alanlarda çalışan sosyal hizmet uzmanlarının etik ikilem ve etik karar verme durumları üzerine nitel bir değerlendirme. *Toplum ve Sosyal Hizmet*. 2023;34(2):313-333. doi: 10.33417/tsh.1071356.
24. Taş A, Karataş K. Bir sosyal inceleme alanı olarak “muhtaçlık” değerlendirmesinde karşılaşılan etik ikilem ve sorunlar. *Toplum ve Sosyal Hizmet*. 2024;35(2):173-199.
25. Walsh-Bowers R, Rossiter A, Prilleltensky I. The personal is the organizational in the ethics of hospital social workers. *Ethics Behav*. 1996;6(4):321-335.
26. Akkuş P. Türkiye’de sosyal hizmetler, neo-liberal politikalar ve etik ikilemler. *Sosyal Siyaset Konferansları Dergisi*. 2021;(81):451-484. doi: 10.26650/jspc.2021.81.836634.
27. McCormick AJ, Stowell-Weiss P, Carson J, et al. Continuing education in ethical decision making using case studies from medical social work. *Soc Work Health Care*. 2014;53(4):344-363. doi: 10.1080/00981389.2014.884042.
28. Pugh GL. Perceptions of the hospital ethical environment among hospital social workers in the United States. *Soc Work Health Care*. 2015;54(3):252-268.

29. Rasoal D, Kihlgren A, James I, Svantesson M. What healthcare teams find ethically difficult. *Nurs Ethics*. 2016;23(8):825-837. doi: 10.1177/0969733015583928.
30. Dursun Y, Atamtürk E, Aslantürk H. Sosyal hizmet uzmanlarının etik ikilemler karşısındaki tutumlarının çeşitli değişkenlere göre incelenmesi. *Tıbbi Sosyal Hizmet Dergisi*. 2022;(19):1-16. doi: 10.46218/tshd.1073318.
31. Kocakaya R, Aydoğan C, Çalık Var E. Sosyal hizmet alanında çalışan profesyonellerin şiddet deneyimleri. *J Soc Sci*. 2018;27:448-460. doi: 10.16990/SOBIDER.4.

Individual Resilience and Protective Mental Health: The Role of Psychological Resilience

Nurten ELKİN*, Ayşe Mücella SOYDAN**

Abstract

This review examines the concepts of psychological resilience and preventive mental health, and their roles in individuals' mental health protection and improvement processes. Psychological resilience represents individuals' capacity to adapt to stressful and challenging life conditions, while the preventive mental health approach aims to strengthen individuals' internal resources and environmental support systems. Literature findings show that psychological resilience is effective not only in preventing mental health problems but also in increasing individuals' life satisfaction and subjective well-being. This highlights the importance of empowering and preventive approaches in addition to risk-focused approaches in mental health practices. It is emphasized that individual characteristics, social support, family, and environmental factors are decisive in the development of psychological resilience; and that the interaction between preventive mental health and psychological resilience plays a crucial role in protecting mental health at both individual and societal levels. The study emphasizes the importance of integrating programs that support psychological resilience into education, work, and community-based mental health services, and highlights the need for longitudinal and experimental studies in future research. This review demonstrates that psychological resilience is a fundamental building block in the preventive mental health perspective and contributes to strengthening mental health at both individual and societal levels.

Keywords: Individual resilience, protective mental health, psychological resilience.

Bireysel Dayanıklılık ve Koruyucu Ruh Sağlığı: Psikolojik Sağlamlığın Rolü

Öz

Bu derleme çalışmada, psikolojik sağlamlık ve koruyucu ruh sağlığı kavramları ele alınmış, bireylerin ruh sağlığını koruma ve geliştirme süreçlerindeki rolleri incelenmiştir. Psikolojik sağlamlık, bireylerin stresli ve zorlayıcı yaşam koşulları karşısında uyum kapasitesini temsil ederken, koruyucu ruh sağlığı yaklaşımı, bireylerin içsel kaynaklarını ve çevresel destek sistemlerini güçlendirmeyi hedeflemektedir. Literatür bulguları, psikolojik sağlamlığın yalnızca ruhsal sorunları önlemekle kalmayıp, bireylerin yaşam doyumu ve öznel iyi oluş düzeylerini artırmada da etkili olduğunu göstermektedir. Bu durum, ruh sağlığı uygulamalarında risk odaklı yaklaşımların yanı sıra güçlendirici ve önleyici yaklaşımın önemini ortaya koymaktadır. Psikolojik sağlamlığın gelişiminde bireysel özellikler, sosyal destek, aile ve çevresel faktörlerin belirleyici olduğu vurgulanmış; koruyucu ruh sağlığı ile psikolojik sağlamlık arasındaki etkileşimin birey ve toplum düzeyinde ruh sağlığının korunması için çok önemli bir rol üstlendiği gösterilmiştir. Çalışma, psikolojik sağlamlığı destekleyen programların eğitim, iş ve toplum temelli ruh sağlığı hizmetlerine entegre edilmesinin önemini ve gelecekte yapılacak araştırmalarda boylamsal ve deneysel çalışmaların gerekliliğini

Derleme Makale (Review Article)

Geliş / Received: 03.02.2026 & **Kabul / Accepted:** 30.07.2026

DOI: <https://doi.org/10.38079/igusabder.1881400>

* Assoc. Prof. Dr., Independent Researcher (Public Health), Istanbul, Türkiye. E-mail: nurtenelkin@gmail.com

ORCID <https://orcid.org/0000-0002-9470-2702>

** Lecturer, Istanbul Gelisim University, Faculty of Health Sciences, Istanbul, Türkiye. E-mail: amsoydan@gelisim.edu.tr

ORCID <https://orcid.org/0000-0002-2755-8456>

vurgulamaktadır. Bu derleme, psikolojik sağlamlığın koruyucu ruh sağlığı perspektifinde temel bir yapı taşı olduğunu ve bireysel ile toplumsal düzeyde ruh sağlığının güçlendirilmesine katkı sağladığını ortaya koymaktadır.

Anahtar Sözcükler: Bireysel dayanıklılık, koruyucu ruh sağlığı, psikolojik sağlamlık.

Introduction

Psychological Resilience

The concept of psychological resilience is derived from the Latin root “resilire”¹, and the term “resilient” signifies flexibility and elasticity². Ramirez³ defines psychological resilience as the ability to recover quickly after illness, depression, change, or adverse life circumstances; to regain composure; to easily return to one's former state after injury or strain in other words, a kind of elasticity. Psychological resilience is considered the capacity of an individual to overcome these adversities and adapt to new situations despite extremely difficult circumstances. In addition to being considered a skill and psychological trait, it also encompasses various qualities such as contributing to the continuation of healthy development and effectively coping with adverse situations⁴.

There is no universally accepted definition of psychological resilience. Nevertheless, there are some important points common to all definitions of psychological resilience. These are that psychological resilience is a dynamic process; it involves successful coping, healthy adaptation, or the development of competence under trauma, challenging life events, or significant risk⁵⁻¹¹.

At the same time, psychological resilience represents a two-dimensional concept. In other words, for psychological resilience to emerge, the individual must be exposed to a risk or challenge, and at the end of this process, by adapting to the situation, they must achieve success in different areas of their life despite all the existing negative conditions. In short, "risk" is stated as the key factor for the emergence of psychological resilience. Individuals who have not been exposed to any traumatic life events but are successful in various areas of life are not considered resilient, but merely successful or competent individuals^{9,10}. In summary, when the existing literature is examined, three fundamental points are commonly expressed in various definitions of the concept of psychological resilience. These are; a) risk and/or difficulty, b) positive adaptation, coping, competence, and c) protective factors. In this case, psychological resilience is defined as "a phenomenon" that arises as a result of the significant interaction of protective factors, which are necessarily associated with healthy adaptation and contribute to the adaptation process, with existing risk factors¹². Risk and protective factors play an important role in the development of psychological resilience. Risk is a prerequisite for the formation of psychological resilience. Risk means the presence of one or more factors or effects that increase the probability of a negative outcome; in other words, any event, situation, or experience that increases the probability of a problem occurring,

continuing, or worsening^{13,14}. Protective factors, on the other hand, are factors that reduce or eliminate the negative effects of risks and adverse conditions³.

From a preventive mental health perspective, psychological resilience is considered not only an individual characteristic but also a developable capacity. Therefore, a key objective of preventive and empowering interventions in the field of mental health is to increase individuals' levels of psychological resilience¹⁵. In particular, programs that support resilience in community-based mental health services are considered an effective approach to improving individuals' quality of life.

In conclusion, psychological resilience is a central concept in the process of protecting an individual's mental health. It supports the individual's psychological adjustment by reducing the negative effects of stressful life events and is considered one of the fundamental components of preventive mental health approaches; this study aims to highlight the concept and importance of psychological resilience from a preventive mental health perspective.

Risk and Protective Factors in the Development of Psychological Resilience

When examining models and theories of psychological resilience in the literature, it is seen that the concept can be innate in an individual, as well as characteristics developed throughout life. A common point among theories in the literature on psychological resilience is that factors that increase resilience are developable, and elements such as family and society are also important¹⁶. Such an approach would lead to the inclusion of strength and competence-based models that focus not only on addressing psychopathology but also on prevention and building strengths¹⁷.

Risk Factors

Risk factors encompass biological, psychological, and social factors that weaken an individual's psychological resilience and increase their susceptibility to mental health problems. Within the framework of the concept of psychological resilience, many different risk factors have been studied, particularly concerning children and young people. When these factors are grouped as individual, familial, and environmental; examples of individual factors include negative life events and chronic illnesses; examples of familial factors include parental illness or psychopathology, parental death, or living with a single parent; examples of environmental factors include economic hardship and poverty, child neglect and abuse, and social traumas such as war and natural disasters¹⁸.

Protective Factors

The term protective factors describes situations that soften, reduce, or eliminate the impact of a risk or challenge, promoting healthy adaptation and improving an individual's competencies¹⁹. Protective factors may include individual characteristics, familial and environmental factors, or situations arising from the interaction of these

dimensions. The important thing is to determine how protective factors reduce or even prevent the existing risk, regardless of which of these dimensions are present²⁰. When the literature is examined, although many different age groups, different cultures, or different risk areas have been examined in psychological resilience studies, most studies have identified many common individual, familial, and environmental protective factors and detailed how these factors function under risk²¹⁻²³. Self-confidence, family support, positive and nurturing peer relationships, and the presence of a mentor in the environment can be given as examples of protective factors.

While some individuals show resilience and become more successful in the face of adverse conditions, others give up easily. Individuals who show more resilience to adverse conditions compared to others can be said to be more resilient. Psychological resilience means that adults exposed to a destructive event can maintain a relatively stable level of psychological and physical functioning²⁴. The different levels of resilience shown by individuals have been explained in the literature from two different perspectives. The first perspective focuses on the personality traits of individuals with psychological resilience, while the second focuses on how the resilience process develops²⁵.

The most important variable between individuals who maintain their development and life functionality despite experiencing similar risk factors and who demonstrate positive adaptation and coping methods, and individuals who cannot cope with risks and cannot adapt, is seen as "protective factors"²⁶. When the international literature is examined, variables such as high self-esteem, adaptable temperament, cognitive flexibility, effective social relationships, and emotional intelligence are seen as protective factors²⁷⁻³⁰. In addition, individuals with high psychological resilience utilize both internal and external resources when coping with negative life events³¹. When evaluated from the perspective of a preventive mental health approach, interventions aimed at increasing the psychological resilience of individuals aim to strengthen protective factors as well as reduce risk factors. This approach aims to prevent mental health problems before they arise and to improve the quality of life of individuals¹⁵.

Studies in the national literature also show parallels with international findings. In a study conducted on university students in Türkiye, it was stated that individuals with a high perception of social support have a higher level of psychological resilience and that the impact of stressful life events on mental health may be more limited³².

Overall, both national and international literature indicate that psychological resilience plays a critical role in maintaining mental health. Research findings suggest that psychological resilience is a construct that can be developed through individual and environmental factors, and should be considered a fundamental component of preventive mental health approaches.

Preventive Mental Health

Preventive mental health is defined as an approach aimed at preventing the onset of mental illnesses, reducing risk factors, and strengthening protective factors that support individuals' mental well-being. This approach treats mental health not merely as an area to be treated, but as a state of well-being that can be improved and sustained^{15,33}.

The foundations of the concept of preventive mental health are based on Caplan's model of preventive psychiatry. Caplan addressed mental health services within the framework of primary, secondary, and tertiary prevention levels; emphasizing that supporting individuals before mental problems arise is more effective both individually and socially³⁴. Primary prevention focuses on preventing the onset of mental disorders; secondary prevention focuses on early diagnosis and intervention; and tertiary prevention focuses on reducing the functional losses caused by the illness.

The World Health Organization (WHO) defines preventive mental health as a holistic approach that includes improving individuals' life skills, strengthening social support systems, and creating healthy environmental conditions. According to the WHO, protecting mental health is a shared responsibility not only of the health sector but also of numerous areas such as education, working life, and social policies^{15,35}.

The importance of a preventive mental health approach has become even more apparent with the increasing share of mental disorders in the global disease burden. Depression, anxiety disorders, and stress-related mental health problems reduce the quality of life of individuals and have serious effects on social functioning. In this context, preventive mental health practices are considered an effective and sustainable strategy in reducing the prevalence of mental illnesses³⁶.

In Türkiye, preventive mental health policies are addressed within the framework of national mental health plans and community-based mental health services. In national policy documents published by the Ministry of Health, strengthening preventive efforts to protect mental health and expanding community-based service models are among the main objectives^{37,38}. Consequently, preventive mental health represents an understanding that supports the mental well-being of individuals, aims to prevent the onset of mental illnesses, and prioritizes community-based approaches. This approach focuses on developing individual protective factors such as psychological resilience, offering holistic and sustainable solutions in the field of mental health.

The Relationship between Preventive Mental Health and Psychological Resilience

The relationship between preventive mental health and psychological resilience has become increasingly clear in recent studies. These two concepts have an overlapping and complementary structure in terms of preventing the emergence of mental health problems and increasing individuals' capacity to cope with stress.

The preventive mental health approach aims to strengthen the individual's internal and environmental resources, reduce risk factors, and support positive adaptation processes^{33,39}. Psychological resilience also acts as a protective mechanism in this process; it contributes to the protection of mental health by increasing individuals' ability to adapt and maintain their well-being in the face of difficulties^{40,41}.

International studies show that psychological resilience is directly related to preventive mental health practices. For example, it is stated that psychological resilience levels increase in individuals who participate in mental health education and support programs, and that this is a key factor in reducing the psychological effects of chronic diseases⁴².

It has also been reported in different sample groups that psychological resilience increases when preventive mental health interventions are carried out in risky living conditions. For example, in a study on adolescents diagnosed with chronic diseases such as leukemia, it was observed that psychological resilience levels were higher in individuals with strong family and social support; this emphasized the importance of environmental protective factors in both protecting mental health and developing psychological resilience⁴³.

These findings demonstrate that running preventive mental health programs in parallel with psychological resilience is an effective way to strengthen individuals' mental health and reduce the risk of psychopathology. Thus, preventive mental health services serve not only to prevent illnesses but also to improve well-being by increasing individuals' psychological resilience.

This study is a traditional narrative review of research addressing the concepts of psychological resilience and preventive mental health. In the review, national and international literature on individual resilience, psychological resilience, and preventive mental health was examined using a non-systematic but structured approach.

In this review, the concepts of psychological resilience and preventive mental health were addressed in light of theoretical and empirical literature; the reciprocal and complementary relationship between these two concepts was emphasized.

From a preventive mental health perspective, supporting individual strengths is paramount in preventing mental health problems. The World Health Organization's approach to promoting mental health lists strengthening individuals' life skills and psychosocial resources as one of its fundamental goals¹⁵.

The studies reviewed in this compilation reveal that environmental and social factors, as well as individual characteristics, are decisive in the development of psychological resilience. Family support, secure attachment relationships, and social support networks enable individuals to be more resilient in the face of stressful life events⁴⁴. This situation shows that preventive mental health practices should be addressed not only with individual-focused but also with community-based approaches.

However, some limitations in the literature are also noteworthy. There are differences in the definition of the concept of psychological resilience and in the tools used for its measurement; this makes it difficult to compare research findings. In addition, the fact that a significant portion of the studies conducted in the national literature have cross-sectional designs limits the establishment of causal relationships. This situation highlights the need for longitudinal and experimental research.

The findings of this review emphasize the importance of integrating interventions aimed at developing psychological resilience with preventive mental health policies. Widespread implementation of programs aimed at increasing psychological resilience in educational institutions, workplaces, and community-based mental health services is considered an effective and sustainable strategy in preventing mental health problems.

Conclusion and Recommendations

This review examines the concepts of psychological resilience and preventive mental health from a holistic perspective, discussing their roles in protecting mental health at both individual and societal levels. The literature reviewed reveals that psychological resilience is a fundamental element that enhances individuals' capacity to adapt to stressful and challenging life events and plays a significant role in protecting mental health.

Psychological resilience is considered not only as a mechanism that prevents the emergence of mental health problems, but also as a structure that supports individuals' psychological well-being and improves their quality of life. In this respect, it strongly overlaps with the concept of preventive mental health; it offers a perspective that goes beyond risk-focused approaches and centers on individuals' strengths and coping capacities. The preventive mental health approach represents a holistic understanding that aims to strengthen individuals' internal resources and improve their environmental support systems. Supporting psychological resilience can be considered one of the fundamental goals of this approach. Widespread implementation of practices aimed at increasing psychological resilience in educational institutions, workplaces, and community-based mental health services offers an effective and sustainable strategy for preventing mental health problems. Based on the findings of this review, it is recommended that preventive and protective programs in the field of mental health should include components aimed at improving psychological resilience. It is thought that early interventions, especially for children, adolescents, and at-risk groups, will contribute to reducing the burden of mental illness in the long term. Furthermore, it is important that mental health services are planned not only with an individual-focused approach but also with a multi-level approach encompassing the family and the community. Future research is recommended to increase longitudinal and experimental studies examining the developmental process of psychological resilience and the effectiveness of preventive mental health practices. Such studies will provide significant contributions to understanding how psychological resilience can be improved and how preventive mental health policies can be made more effective. In conclusion, psychological resilience is one of the fundamental building blocks of a preventive mental

health approach. Supporting psychological resilience at the individual and societal levels offers a strong, feasible, and sustainable approach to protecting and improving mental health.

REFERENCES

1. Masten AS, Gewirtz AH. Resilience in development: The importance of early childhood. In: Tremblay RE, Barr RG, Peters RDeV, eds. *Encyclopedia on Early Childhood Development*. Montreal, Quebec: Centre of Excellence for Early Childhood Development; 2006.
https://www.researchgate.net/publication/252094504_Resilience_in_Development_The_Importance_of_Early_Childhood.
2. Hunter AJ, Chandler GE. Adolescent resilience. *Image: Journal of Nursing Scholarship (Third Quarter)*. 1999;31:243-247.
3. Ramirez ER. Resilience: A concept analysis. *Nursing Forum*. 2007;42:73-82.
4. Masten AS, Coatsworth JD. The development of competence in favorable and unfavorable environments: Lessons from research on successful children. *American Psychologist*. 1998;53:205-220.
5. Garmezy N, Masten AS, Tellegen A. The study of stress and competence in children: A building block for developmental psychopathology. *Child Dev*. 1984;55:97-111.
6. Rutter M. Psychosocial resilience and protective mechanisms. In: Rolf JE, Masten AS, Cicchetti D, Nuechterlein KH, Weintraub S, eds. *Risk and Protective Factors in the Development of Psychopathology*. New York: Cambridge University Press; 1990:181-214. doi: 10.1017/CBO9780511752872.013.
7. Rutter M. Resilience concepts and findings: Implications for family therapy. *J Fam Ther*. 1999;21:119-144.
8. Doll B, Lyon MA. Risk and resilience: Implications for the delivery of educational and mental health services in schools. *Sch Psychol Rev*. 1998;27(3):348-363.
9. Luthar S, Cicchetti D. The construct of resilience: Implications for interventions and social policies. *Dev Psychopathol*. 2000;12:857-885.
10. Luthar S, Cicchetti D, Becker B. The construct of resilience: A critical evaluation and guidelines for future work. *Child Dev*. 2000;71(3):543-562.

11. Masten AS, Reed MGJ. Resilience in development. In: Snyder CR, Lopez SJ, eds. *Handbook of Positive Psychology*. New York: Oxford University Press; 2002:74-88. doi: 10.1093/oso/9780195135336.003.0006.
12. Windle M. Critical conceptual and measurement issues in the study of resilience. In: Glantz MD, Johnson JL, eds. *Resilience and Development: Positive Life Adaptations*. New York: Kluwer Academic/Plenum Publishers; 1999.
13. Dion Stout M, Kipling G. Aboriginal People, Resilience and the Residential School Legacy. Ottawa, Ontario: Aboriginal Healing Foundation; 2003.
<https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/resilience.pdf>.
14. Jenson JM, Fraser MW. A risk and resilience framework for child, youth, and family policy. In: Jenson JM, Fraser MW, eds. *Social Policy for Children and Families: A Risk and Resilience Perspective*. Thousand Oaks, CA: Sage Publications; 2006. https://us.sagepub.com/sites/default/files/upm-binaries/37820_Chapter1.pdf.
15. World Health Organization. Prevention of Mental Disorders: Effective Interventions and Policy Options. Summary Report. Geneva: World Health Organization; 2004.
16. Öztörel İ. Psikolojik danışman adaylarının psikolojik sağlamlık, yaşam doyumu ve affetme düzeylerinin incelenmesi [master's thesis]. Lefkoşa, Kuzey Kıbrıs Türk Cumhuriyeti: Rehberlik ve Psikolojik Danışmanlık Anabilim Dalı, Eğitim Bilimleri Enstitüsü; 2018.
17. Southwick SM, Bonanno GA, Masten AS, Panter-Brick C, Yehuda R. Resilience definitions, theory, and challenges: Interdisciplinary perspectives. *Eur J Psychotraumatol*. 2014;5:25338. doi:10.3402/ejpt.v5.25338.
18. Gizir CA. Psikolojik sağlamlık, risk faktörleri ve koruyucu faktörler üzerine bir derleme çalışması. *Türk Psikolojik Danışma ve Rehberlik Dergisi*. 2007; 3: 113-128.
19. Masten AS. Resilience in Individual Development: Successful Adaptation Despite Risk and Adversity. In: Wang MC, Gordon EW, eds. *Educational Resilience in Inner-City America: Challenges and Prospects*. Hillsdale (NJ): Lawrence Erlbaum; 1994.
20. Greene R, Conrad AP. Basic Assumptions and Terms. In: Greene R, ed. *Resiliency: An Integrated Approach to Practice, Policy, and Research*. Washington (DC): NASW Press; 2002.
21. Kumpfer KL. Factors and Processes Contributing to Resilience: The Resilience Framework. In: Glantz MD, Johnson JL, eds. *Resilience and Development:*

Positive Life Adaptations. New York: Kluwer Academic/Plenum Publishers; 1999.

22. Luthar S. *Poverty and Children's Adjustment*. Newbury Park (CA): Sage; 1999.
23. Mandleco BL, Peery JC. An organizational framework for conceptualizing resilience in children. *J Child Adolesc Psychiatr Nurs*. 2000;13(3):99-111.
24. Bonanno GA. Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *Am Psychol*. 2004;59(1):20-28. doi:10.1037/0003-066X.59.1.20.
25. Çetin F, Yeloğlu HO, Basım HN. Psikolojik dayanıklılığın açıklanmasında beş faktör kişilik özelliklerinin rolü: Bir kanonik ilişki analizi. *Turk Psikol Derg*. 2015;30(75):81-92.
26. Masten AS, Powell JL. A Resilience Framework for Research, Policy, and Practice. In: Luthar S, eds. *Resilience and Vulnerabilities: Adaptation in the Context of Childhood Adversities*. New York: Cambridge University Press; 2003.
27. Crocker J, Park LE. The costly pursuit of self-esteem. *Psychol Bull*. 2004;130:392-414.
28. Masten AS. *Ordinary Magic: Resilience in Development*. New York: Guilford Press; 2014.
29. Olsson CA, Bond JM, Vella-Brodrick DA, Sawyer SM. Adolescent resilience: A concept analysis. *J Adolesc*. 2003;26:1-11.
30. Schneider TR, Lyons JB, Khazon S. Emotional intelligence and resilience. *Pers Individ Dif*. 2013;55:909-914.
31. Karairmak Ö. Psikolojik sağlamlık, risk faktörleri ve koruyucu faktörler. *Turk Psikol Danis Rehberlik Derg*. 2006;3(26):129-142.
32. Terzi Ş. The relationship between psychological resilience and perceived social support in university students. *Turkish Journal of Psychological Counseling and Guidance*. 2006;3(26):1-12.
33. Barry MM, Jenkins R. *Implementing Mental Health Promotion*. Edinburgh: Churchill Livingstone Elsevier; 2007.
34. Caplan G. *Principles of Preventive Psychiatry*. New York: Basic Books; 1964.
35. World Health Organization. Guidance on Community Mental Health Services: Promoting Person-Centred and Rights-Based Approaches. Geneva: World Health Organization; 2021. <https://www.who.int/publications/i/item/9789240025707>.

36. World Health Organization. Comprehensive Mental Health Action Plan 2013-2030. Geneva: World Health Organization; 2021.
<https://www.who.int/publications/i/item/9789240031029>.
37. T.C. Sağlık Bakanlığı. Türkiye Ruh Sağlığı Politikası. Ankara: T.C. Sağlık Bakanlığı; 2006.
38. T.C. Sağlık Bakanlığı. Ulusal Ruh Sağlığı Eylem Planı (2011-2023). Sağlık Bakanlığı Yayın No: 847. Ankara: T.C. Sağlık Bakanlığı; 2011.
39. Tufan D, Tutarel-Kışlak Ş. Koruyucu ruh sağlığı temelinde psikolojik sağlamlık kavramının incelenmesi. In: International Cappadocia Social Sciences Congress; Nov 7-9, 2019; Niğde, Turkey.
40. Soylu Y. Pandemi döneminde çocuk ve ergenlerin ruh sağlığı açısından önemli bir kavram: Psikolojik sağlamlık. In: Gençdoğan B, ed. *Pandemi Döneminde Çocuk ve Ergen Psikolojisi*. 1st ed. Ankara: Türkiye Klinikleri; 2020.
41. Coşkun B. Strengthening mental health from a preventive psychiatry perspective. *Türkiye Klinikleri Journal of Psychiatry Special Topics*. 2011;4(4):110–9.
42. Sharma S, Shrivastava A, Singh A. Resilience in management of chronic diseases: A review of strategies, approaches, and interventions. *Discover Public Health*. 2025;22:724.
43. Pars H, Çavuşoğlu H. Examining the psychological resilience of adolescents with leukemia: A comparative study. *Florence Nightingale Journal of Nursing*. 2019;27(2):104–118.
44. Ozbay F, Johnson DC, Dimoulas E, Morgan CA, Charney D, Southwick S. Social support and resilience to stress. *Psychiatry*. 2007;4:35–40.

The Role of Nutrition Therapy in the Management of Chronic Pain

Hatice Tuğçe BERBEROĞLU*, Muteber Gizem KESER GÜMÜŞ**

Abstract

Chronic pain is defined as pain lasting longer than three months or recurring in nature and is considered a major public health problem affecting millions of people worldwide. This condition, which significantly reduces quality of daily life and may lead to physical, psychological, and social problems, can negatively affect individuals' lives over the long term. Although the mechanisms underlying the development of chronic pain have not yet been fully understood, recent scientific studies suggest that certain biological processes may play a role in its development. Among these processes, oxidative stress, inflammation, increased body weight, and imbalance in gut microbiota (dysbiosis) are particularly prominent. Notably, most of these factors are closely associated with nutrition either directly or indirectly. Therefore, investigating the effects of nutrition on the development and severity of chronic pain may enable the development of nutrition-based approaches aimed at reducing pain. This review discusses the possible biological mechanisms involved in the pathogenesis of chronic pain and examines the role and potential contributions of nutrition therapy in this process. Thus, the importance of nutrition as a complementary approach in the prevention and management of chronic pain is emphasized.

Keywords: Chronic pain, oxidative stress, inflammation, dysbiosis, nutrition.

Kronik Ağrı Yönetiminde Beslenme Tedavisinin Rolü

Öz

Kronik ağrı, üç aydan uzun süren veya tekrarlayıcı nitelikte olan ağrı olarak tanımlanmakta ve dünya genelinde milyonlarca insanı etkileyen önemli bir halk sağlığı problemi olarak kabul edilmektedir. Günlük yaşam kalitesini önemli ölçüde düşüren, fiziksel, psikolojik ve sosyal sorunlara yol açabilen bu durum, bireylerin yaşamlarını uzun süreli olarak olumsuz etkileyebilmektedir. Kronik ağrının oluşum mekanizmaları henüz tam olarak aydınlatılamamış olsa da, son yıllarda yapılan bilimsel araştırmalar, bazı biyolojik süreçlerin bu durumun gelişiminde rol oynayabileceğini göstermektedir. Bu süreçler arasında oksidatif stres, inflamasyon, artmış vücut ağırlığı ve bağırsak mikrobiyotasında görülen dengesizlik (disbiyozis) öne çıkmaktadır. Dikkat çekici olan nokta ise bu faktörlerin çoğunun doğrudan ya da dolaylı olarak beslenme ile yakından ilişki içinde olmasıdır. Bu nedenle, beslenmenin kronik ağrının oluşumu ve şiddeti üzerindeki etkilerini araştırmak, ağrıyı azaltmaya yönelik beslenme temelli yaklaşımların geliştirilmesini mümkün kılabilir. Bu derlemede, kronik ağrı patogeneğinde rol oynayan olası biyolojik mekanizmalar ele alınmakta ve beslenme tedavisinin bu süreçteki yeri ve potansiyel katkıları

Derleme Makale (Review Article)

Geliş / Received: 21.07.2025 & **Kabul / Accepted:** 29.07.2026

DOI: <https://doi.org/10.38079/igusabder.1747475>

* Res. Asst., Department of Nutrition and Dietetics, Faculty of Health Sciences, KTO Karatay University, Konya, Türkiye.

E-mail: tugceaca@gmail.com [ORCID https://orcid.org/0000-0002-7098-7344](https://orcid.org/0000-0002-7098-7344)

** Asst. Prof. Dr., Department of Nutrition and Dietetics, Nezahat Keleşoğlu Faculty of Health Sciences, Necmettin Erbakan University, Konya, Türkiye. E-mail: mgizemkeser@gmail.com [ORCID https://orcid.org/0000-0001-9425-9088](https://orcid.org/0000-0001-9425-9088)

incelenmektedir. Böylece, kronik ağrının önlenmesi ve yönetiminde tamamlayıcı bir yaklaşım olarak beslenmenin önemi vurgulanmaktadır.

Anahtar Sözcükler: Kronik ağrı, oksidatif stres, inflamasyon, disbiyozis, beslenme.

Introduction

According to the International Association for the Study of Pain (IASP), chronic pain is pain that persists or recurs for longer than three months¹. Chronic pain affects millions of individuals worldwide and represents a major public health concern as well as one of the leading causes of disability². Although large-scale studies investigating the prevalence of chronic pain remain limited, available evidence indicates that its prevalence varies considerably across populations and societies^{3,4}. It is estimated to affect more than one-third of adults globally, including approximately one in five adults in Europe⁵, and its prevalence is predicted to increase further in the coming years⁶.

The underlying mechanisms involved in the development of chronic pain have not yet been fully elucidated, making it challenging to establish definitive treatment approaches for this widespread health problem. The severity, duration, and impact of chronic pain are influenced by a wide range of social, psychological, physical, and emotional factors. In addition to these factors, nutrition has also been reported to play a role in the development and progression of chronic pain⁷⁻⁹. Chronic pain may impair individuals' ability to perform daily activities and engage in physical exercise, while also contributing to poor sleep quality and reduced participation in social activities¹⁰. Furthermore, it imposes a substantial socioeconomic burden through functional impairment, disability, increased healthcare utilization and costs, absenteeism, and reduced productivity¹¹.

Current treatment standards emphasize a multifaceted and multidisciplinary approach that acknowledges the complex interactions among biological, psychological, and social factors⁷. These strategies offer an alternative to traditional pain management approaches and may reduce the adverse effects associated with pharmacological interventions while enhancing their therapeutic effectiveness². In this context, nutrition has increasingly emerged as an important lifestyle factor in pain management². Evidence suggests that poor dietary habits, including inadequate and unhealthy nutrition, may substantially influence the onset, progression, and persistence of chronic pain¹². The relationship between nutrition and chronic pain is highly complex and is thought to involve several underlying mechanisms, including oxidative stress, inflammation, and alterations in the gut microbiota¹³.

Although evidence supporting the role of nutrition in chronic pain management is steadily increasing, the mechanisms underlying the interaction between nutrition and chronic pain, as well as the effective implementation of nutritional care in this context, remain incompletely understood. Therefore, this review aims to discuss the biological mechanisms underlying this interaction in individuals experiencing chronic pain and to examine the role of nutritional management in pain prevention and treatment.

Material and Methods

This article was prepared as a narrative review aiming to summarize the current approaches regarding the role of nutrition therapy in the management of chronic pain. A literature search was conducted in PubMed, Scopus, and Google Scholar databases for studies published between January 2010 and March 2025. Search terms included combinations of “chronic pain”, “nutrition”, “diet”, “Mediterranean diet”, “inflammation”, “oxidative stress”, “gut microbiota”, “obesity”, “vitamin D”, “omega-3 fatty acids”, and “micronutrients”.

Original research articles, systematic reviews, meta-analyses, and clinical guidelines published in English were considered for inclusion. Studies focusing on acute pain, animal models without clinical relevance, or publications lacking sufficient methodological information were excluded. Relevant articles were selected based on their contribution to understanding the biological mechanisms linking nutrition and chronic pain and the potential role of nutritional interventions in pain management.

Mechanisms Underlying the Relationship between Chronic Pain and Nutrition

The mechanisms through which nutrition contributes to chronic pain have not yet been fully elucidated. Therefore, identifying these mechanisms may improve the effectiveness of nutritional therapy in the management of chronic pain¹³. Several nutrition-related factors have been implicated in the development and persistence of pain, including oxidative stress, inflammation, obesity, and gut dysbiosis.

Oxidative stress is a pathophysiological condition characterized by the excessive intracellular accumulation of reactive oxygen species (ROS), reactive nitrogen species (RNS), and other free radical species¹⁴. Oxidative stress is considered one of the major pathophysiological mechanisms underlying chronic pain. It can be influenced by dietary factors and plays a significant role in the initiation and progression of inflammation¹⁵. Oxidative stress may lead to harmful alterations, particularly within the central nervous system. Previous studies have demonstrated an imbalance between pro-oxidant and antioxidant mechanisms in individuals experiencing chronic pain¹⁶⁻¹⁸. Furthermore, oxidative stress can damage neural tissues, increase pain sensitivity, and contribute to the development of neuropathy². It has been associated with several chronic pain conditions, including osteoarthritis, fibromyalgia, and neuropathic disorders². In contrast, evidence suggests that a high dietary intake of antioxidants and improved endogenous detoxification capacity may help alleviate chronic musculoskeletal pain¹⁹.

Inflammation also plays a central role in the development of chronic pain. It contributes not only to the onset, persistence, and prognosis of chronic pain, but also to the development of various acute and chronic diseases¹³. A nutrient-rich diet is believed to alleviate pain by reducing oxidative stress and systemic inflammation²⁰. Previous studies

have demonstrated that diets high in animal-based foods are associated with increased inflammation and chronic pain²¹, whereas dietary patterns rich in refined sugars, saturated fats, trans fats, and artificial additives may promote chronic low-grade inflammation, which has been linked to several chronic pain-related conditions, including arthritis, fibromyalgia, and migraine².

In contrast, the consumption of antioxidant-rich foods such as fruits and vegetables, whole grains, fatty fish, nuts, seeds, and olive oil may help reduce inflammation and alleviate pain². In an exploratory pilot case-control study conducted by Jönsson et al., involving patients with chronic peripheral neuropathic pain and healthy controls, participants with neuropathic pain exhibited an altered lipoprotein profile consistent with low-grade chronic inflammation²². Although the metabolic mechanisms underlying chronic pain in individuals with diabetes have not yet been fully clarified, chronic pain is thought to arise from a pro-inflammatory state associated with impaired lipid metabolism, ion channel alterations, central and peripheral sensitization, and microglial activation²³. Therefore, the identification and management of impaired glucose metabolism may also play a crucial role in chronic pain management²⁴.

Gut dysbiosis has emerged as another important mechanism linking nutrition and chronic pain. Evidence from animal models suggests that gut health may play a significant role in modulating pain perception or contributing to the development of various chronic pain conditions²⁵. Current evidence also indicates that nutrition may influence the relationship between the gut microbiota and the pathophysiology of both acute and chronic pain²⁶. Dietary patterns characterized by high intakes of saturated fats and refined carbohydrates, together with low consumption of vegetables, fruits, and other nutrient-rich foods, may promote intestinal inflammation²⁷. In contrast, plant-based dietary patterns such as vegan and vegetarian diets have been shown to exert beneficial effects on the gut microbiota²⁸.

Reduced microbial diversity has been reported in individuals with chronic pain, suggesting a potential need for nutritional interventions targeting the gut microbiota²⁹. The gut microbiota also produces polyamines, which can stimulate N-methyl-D-aspartate (NMDA) receptors³⁰. These receptors are known to play a critical role in central sensitization, a mechanism commonly observed in patients with chronic pain²⁷. In addition, a reduced abundance of the bacterial family *Lachnospiraceae* has been identified in patients with chronic pain²⁹.

Several studies have investigated the potential effects of probiotic supplementation on pain-related outcomes. In a clinical intervention study involving 40 patients with Parkinson's disease and constipation, supplementation with *Lactobacillus casei* Shirota for six weeks improved abdominal pain and bowel function³¹. However, in a pilot randomized placebo-controlled trial involving 40 women with fibromyalgia, Roman et al. reported that eight weeks of probiotic supplementation did not significantly improve pain symptoms compared with placebo³². Nevertheless, probiotic supplementation containing *Lactobacillus* and *Bifidobacterium* species has been reported to improve decision-making abilities and attentional processes, even in the absence of direct

reductions in pain intensity. This discrepancy may be explained by the possibility that probiotics contribute to the modulation of neuroinflammation but may be insufficient to reverse long-standing central sensitization within a relatively short intervention period. In contrast, improvements in mood and cognitive function may occur more rapidly through biochemical and neuroimmune pathways. Therefore, although probiotics may not provide acute immediate analgesic effects, they may help prevent the negative consequences of chronic pain on mood, sleep quality, and overall quality of life.

Lastly, maintaining an ideal body weight is important as it protects individuals from numerous diseases and related health complications. Recent studies have demonstrated a bidirectional relationship between obesity and chronic pain³³. Obesity may contribute to pain through the activation of pro-inflammatory pathways and increased mechanical loading on the musculoskeletal system³⁴. It has been associated with several chronic musculoskeletal pain conditions, including osteoarthritis, fibromyalgia, pelvic pain, and chronic low back pain³⁵.

In a registry-based cross-sectional study conducted by Dong et al. including more than 4,000 patients with chronic pain, over 25% of participants were classified as obese³⁶. Similarly, in a cross-sectional study of patients attending a tertiary pain service, obesity was present in approximately 45% of participants³⁷. Research focusing on fibromyalgia has further shown that individuals with overweight or obesity tend to experience more severe pain and require greater medication use compared with those with an ideal body weight^{38,39}. Moreover, calorie-restricted dietary patterns have been shown to alleviate pain in individuals with chronic musculoskeletal disorders⁴⁰.

The relationship between obesity and chronic pain appears to be reciprocal. Chronic pain may alter the sensory and reward-related aspects of eating behavior, potentially reducing satiety regulation and increasing the risk of overconsumption⁴¹. In addition, chronic pain can impair individuals' ability to prepare healthy meals and maintain healthy eating habits, thereby further contributing to the development and persistence of obesity³⁴.

Nutrition Therapy for Pain Management

Dietary habits influence overall lifestyle and health status and may therefore affect both the severity of pain and individuals' ability to cope with it. Over the past two decades, increasing attention has been directed towards the role of nutrition in pain management by pain organizations, healthcare professionals, and consumers alike. Interest in nutrition-based approaches has grown substantially as accumulating evidence has highlighted the potential benefits of dietary interventions in alleviating pain and improving quality of life.

In 2020, the International Association for the Study of Pain emphasized the importance of healthy nutrition as a component of pain management. This recommendation was supported by a growing body of evidence demonstrating that dietary factors may contribute to pain reduction and improve pain-related outcomes⁴².

Macro and Micronutrients

The Mediterranean diet represents not only a nutritional model but also a broader cultural and lifestyle pattern. It is characterized by a high intake of olive oil, vegetables, fruits, whole grains, legumes, and nuts; moderate consumption of fish, seafood, eggs, and dairy products; and low consumption of sweets, red meat, and processed meat⁴³.

This dietary pattern is predominantly plant-based, with meals centered around vegetables, fruits, herbs, nuts, beans, and whole grains. It also includes moderate amounts of dairy products, poultry, eggs, and seafood, whereas red meat is consumed infrequently⁴³. The Mediterranean diet is rich in antioxidant-containing foods, including fresh fruits and vegetables, as well as fish that provide omega-3 fatty acids that reduce inflammation. In addition, olive oil contains several bioactive compounds and antioxidants, including vitamin E, oleic acid, and carotenoids⁴².

Extra virgin olive oil, in particular, contains oleocanthal, a bioactive compound with anti-inflammatory properties. Oleocanthal has been shown to influence prostaglandin-related inflammatory pathways and has demonstrated effects comparable to those of certain non-steroidal anti-inflammatory drugs used in pain reduction⁴³. Furthermore, dietary patterns rich in antioxidants and linolenic acid, such as the Mediterranean diet, may help counteract oxidative damage associated with lipid accumulation and inflammation^{43,44}. In a prospective intervention study involving women with fibromyalgia, eight weeks of adherence to the Mediterranean diet was associated with improvements in disability, fatigue, and anxiety scores⁴⁴.

Carbohydrates

Carbohydrates serve as a primary and rapid source of energy for the body. Glucose, the fundamental form of carbohydrate, is the main energy substrate for bodily functions, particularly for the nervous system. However, excessive dietary carbohydrate intake and impaired glucose utilization may contribute to increased production of reactive oxygen species and oxidative damage²². The World Health Organization (WHO) recommends that added sugars should account for no more than 10% of an individual's total daily energy intake⁴².

In addition to the quantity of carbohydrates consumed, the quality and type of carbohydrates are also important in maintaining metabolic health and managing chronic pain. The glycemic index is a classification system that categorizes foods according to the rate at which they are digested, absorbed, and subsequently increase blood glucose levels. Foods with a low glycemic index are digested and absorbed more slowly than foods with a high glycemic index, thereby promoting more stable blood glucose regulation¹².

The consumption of fresh fruits and vegetables of various colors should be encouraged due to their high phytochemical content. Similarly, whole-grain bread and cereal

products represent healthier carbohydrate sources because they are rich in dietary fiber and B vitamins and generally possess a lower glycemic index. In addition, dietary fiber supports the growth of beneficial gut microbiota by acting as a prebiotic, thereby contributing to the regulation of gut microbial balance. Furthermore, adequate fiber intake may indirectly reduce lipid levels and decrease the risk of inflammation and oxidative stress¹².

Conversely, excessive fructose intake, particularly from sugar-sweetened beverages and ultra-processed foods, may lead to the production of pro-inflammatory cytokines, cholesterol accumulation, endothelial dysfunction, and systemic inflammation^{43,44}. Therefore, limiting the consumption of carbonated beverages, sugary drinks, and ultra-processed, energy-dense, nutrient-poor foods may help reduce oxidative stress and alleviate pain-related symptoms¹².

Proteins

Proteins perform a wide range of essential physiological functions in the body and are composed of amino acids. Essential amino acids play a critical role in the regulation of muscle anabolism and protein synthesis. In addition, several neurotransmitters and pain-modulating compounds, including serotonin, gamma-aminobutyric acid (GABA), and endorphins, are synthesized from amino acid precursors⁴⁵.

Endorphins are endogenous neuropeptides that exert opioid-like effects within the body and contribute to natural pain relief, in some cases demonstrating analgesic effects comparable to morphine. Adequate protein intake is therefore important not only for maintaining muscle mass but also for supporting neurotransmitter synthesis and neuromuscular function. Research has suggested that a daily protein intake of approximately 90-100 g may help prevent neurotransmitter depletion and significant muscle loss. Furthermore, higher protein intake has been associated with reduced pain severity in individuals with fibromyalgia. Another study reported that insufficient protein intake may contribute to fibromyalgia-related symptoms through disruptions in the tryptophan-serotonin metabolic pathway resulting from inadequate tryptophan availability.⁴⁶

Lipids

Lipids are energy-dense molecules that perform numerous essential physiological functions within the body. However, excessive intake of saturated fats and certain polyunsaturated fatty acids, particularly linoleic acid, has been associated with increased levels of total cholesterol, low-density lipoprotein cholesterol, triglycerides, and elevated cardiovascular risk^{47,48}. Diets high in saturated fat and energy-dense foods may also increase circulating concentrations of inflammatory cytokines, thereby contributing to systemic inflammation. A study involving 605 adults demonstrated that increases in the ratio of omega-6 to omega-3 polyunsaturated fatty acids (n-6/n-3 PUFA ratio) were associated with higher pain level⁴⁹.

Similarly, a meta-analysis of fourteen studies reported a significant association between total body fat levels and widespread pain. Individuals with low back pain and knee pain were found to have higher body fat percentages, suggesting a relationship between adiposity and chronic musculoskeletal pain⁵⁰. In contrast, omega-3 polyunsaturated fatty acids have been reported to exert anti-inflammatory and analgesic effects. In a double-blind randomized placebo-controlled trial involving patients with chronic migraine receiving amitriptyline therapy, omega-3 supplementation for 60 days was associated with a reduction in migraine frequency⁵¹. These findings provide preliminary evidence supporting a potential role for omega-3 fatty acids in migraine management; however, larger trials are needed to confirm these effects.

Micronutrients

In addition to macronutrients, inadequate dietary intake of micronutrients, particularly vitamins and minerals such as vitamin D, magnesium, zinc, and vitamins B₁, B₆, and B₁₂, has been suggested to be associated with chronic pain⁵².

Vitamin D plays an important role in the regulation of several inflammatory pathways involved in the development and persistence of chronic pain. Due to its anti-inflammatory properties, vitamin D may also modulate peripheral pain sensitization⁵³. Furthermore, vitamin D deficiency has been associated with increased levels of pro-inflammatory cytokines, which may impair pain signal processing within both the peripheral and central nervous systems⁵⁴.

In a randomized study involving 50 vitamin D-deficient women aged 18–30 years, vitamin D supplementation for eight weeks was associated with reduced pain severity. However, the findings are limited by the relatively small sample size and specific study population⁵⁵. Similarly, in a randomized placebo-controlled trial conducted by Zarei et al. involving 85 students aged 18–32 years, participants were assigned to one of three groups: a calcium plus vitamin D₃ group (1000 mg of calcium and 15,000 IU of vitamin D₃ daily), a calcium-only group (1000 mg calcium daily), or a placebo group⁵⁶. Mean pain intensity decreased in both supplementation groups; however, the reduction reached statistical significance only in the calcium-only group.

Magnesium is an essential macro element with important regulatory functions in both the nervous and muscular systems. The wide range of physiological roles performed by magnesium is reflected in the diverse clinical manifestations associated with its deficiency, which may include irritability, muscle weakness and fatigue, seizures, cardiac arrhythmias, and other neuromuscular disturbances⁵⁷. Magnesium contributes to the stabilization of neuronal cell membranes and has been reported to exert antinociceptive effects, thereby helping to reduce pain associated with tissue injury⁵⁸. In a retrospective cohort study of patients undergoing total knee arthroplasty, perioperative magnesium sulfate administration was associated with a 62% lower incidence of persistent postoperative pain at one-year follow-up⁵⁹.

Zinc is a trace mineral that plays an essential role in DNA synthesis, cell division, and immune system regulation. Within the central nervous system, zinc is also an important micronutrient involved in cognitive function, memory development, glucose homeostasis, and learning processes, in addition to acting as a neuromodulator of synaptic plasticity⁶⁰. The contribution of zinc to pain modulation is thought to occur through its interaction with N-methyl-D-aspartate (NMDA) receptors, which are linked to neuronal nitric oxide synthase (nNOS) activity⁶¹. In a randomized controlled trial conducted by Teimoori et al., participants aged 18–26 years with primary dysmenorrhea were assigned to receive either 220 mg zinc sulfate once daily combined with 250 mg mefenamic acid three times daily, or placebo. The results showed that the intervention group experienced a greater reduction in pain intensity compared with the control group⁶².

Vitamin B₁ is a water-soluble vitamin involved in neural activity, muscle tone regulation, carbohydrate metabolism, blood cell formation, cellular differentiation, and synapse formation. It promotes the synthesis of myelin and several neurotransmitters, including acetylcholine and serotonin. In addition, vitamin B₁ inhibits the activity of acetylcholine esterase, an enzyme responsible for the breakdown of acetylcholine, which is a key neurotransmitter in the central nervous system⁶³. Vitamin B₁ may also contribute to pain reduction by enhancing mitochondrial function and reducing oxidative stress⁶⁴. In a randomized placebo-controlled study by Hosseinlou et al., participants were divided into four groups: vitamin B₁ alone, fish oil supplementation, a combination of vitamin B₁ and fish oil, and placebo. All treatment groups showed a significant reduction in pain severity compared with the placebo group⁶⁵.

Vitamin B₆ (pyridoxine) exists in nature in three forms: pyridoxine, pyridoxal, and pyridoxamine. The biologically active metabolite derived from these compounds is pyridoxal 5'-phosphate (PLP), which is responsible for the physiological functions of the vitamin. Pyridoxal 5'-phosphate participates in numerous metabolic and biochemical processes, including fatty acid metabolism, neurotransmitter synthesis, immune regulation, gluconeogenesis, folate metabolism, coenzyme Q10 synthesis, and heme synthesis⁶⁶.

Vitamin B₆ is thought to exert potential analgesic and neuroprotective effects through several mechanisms, including inhibition of advanced glycation end products, reduction of oxidative stress, modulation of intracellular glutamate concentrations, regulation of calcium channel activity, and antagonist effects on various receptors involved in pain signalling⁶⁶.

In a study conducted by Sadeghi et al., daily supplementation with 80 mg of pyridoxine was associated with reductions in both the severity and duration of migraine attacks⁶⁷. In contrast, another study involving both individuals with fibromyalgia and healthy controls reported that vitamin B₆ supplementation was not significantly more effective than placebo⁶⁸. The inconsistent findings regarding the therapeutic effects of Vitamin B₆ may be attributable to several factors. Vitamin B₆ often requires synergistic micronutrients, such as magnesium, to function effectively as a cofactor in

neurotransmitter synthesis and other metabolic pathways. Thus, deficiencies in these complementary nutrients may limit the clinical efficacy of vitamin B₆ supplementation. Furthermore, the high placebo response commonly observed in fibromyalgia trials may make it difficult to detect the relatively subtle biochemical effects associated with individual vitamin interventions.

Vitamin B₁₂ exerts multiple biological effects that may contribute to pain modulation. Its mechanisms of action include antinociceptive effects, promotion of neuronal regeneration, and participation in myelin synthesis, as well as stimulation of axonal growth and differentiation of Schwann cells⁶⁹. Vitamin B₁₂ is also involved in DNA methylation and plays an essential role in cell replication and the upregulation of brain-derived neurotrophic factor expression. Several mechanisms have been proposed to explain the neuroprotective effects of vitamin B₁₂. These include reduction of advanced glycation end products, inhibition of the diacylglycerol-protein kinase C (DAG-PKC) pathway, and regulation of the hexosamine and pentose metabolic pathways⁷⁰. In addition, vitamin B₁₂ contributes to the regulation of inflammatory mediators and may therefore help alleviate pain-related symptoms. Low serum vitamin B₁₂ concentrations, particularly levels below 400 pg/mL, have been suggested to be associated with tension-type headaches, migraine, and other headache disorders⁷¹.

A prospective cohort study involving chronic hemodialysis patients with diabetic polyneuropathy demonstrated improvements in neuropathic pain following six months of intravenous methylcobalamin treatment. In this six-month study, patients undergoing regular hemodialysis treatment for uremia and diabetic polyneuropathy received 500 µg of intravenous methylcobalamin three times weekly. Improvements in neuropathic pain were observed among patients receiving vitamin B₁₂ treatment⁷².

Similarly, in a randomized placebo-controlled trial involving 71 cancer patients receiving chemotherapy, Schloss et al. evaluated the effectiveness of B-vitamin supplementation in preventing chemotherapy-induced peripheral neuropathy (CIPN). Participants were randomly assigned to receive either placebo or a vitamin formulation containing 50 mg thiamine, 20 mg riboflavin, 100 mg niacin, 163.5 mg pantothenic acid, 30 mg pyridoxine, 500 µg folate (B₉), 500 µg cyanocobalamin, 500 µg biotin, 100 mg choline, and 500 µg inositol twice daily. At the 34-week follow-up assessment, vitamin supplementation did not significantly reduce the incidence of CIPN or pain scores compared with placebo⁷³. The functional roles of macro- and micronutrients in the mechanisms underlying chronic pain development are summarized in Table 1.

Table 1. Functional Roles of Macro- and Micronutrients in the Mechanisms Underlying Chronic Pain.

Nutrient	Key Mechanisms	Pain-Related Outcomes	Level of Evidence
Carbohydrates	High GI → ↑ ROS and inflammation Low GI → glucose stability Fiber → gut microbiota support	Improved pain regulation ↓ inflammatory load	1,3,4,5
Proteins	Amino acids → serotonin, GABA, endorphins Supports muscle synthesis Prevents neurotransmitter depletion	↓ pain sensitivity Improved muscle function	1,4
Fats	Omega-3 fatty acids → anti-inflammatory cytokines Saturated fat → ↑ inflammation n-6/n-3 imbalance → pain risk	Omega-3 → pain reduction Saturated fat → pain aggravation	1,2,3,5
Vitamin D	↓ Pro-inflammatory cytokines Modulates pain sensitization pathways Immune regulation	↓ pain severity Improved inflammatory control	2,3,5
Magnesium	NMDA receptor inhibition Neuronal stabilization Antinociceptive action	↓ acute & chronic pain Improved neuromuscular balance	3,5
Zinc	NMDA modulation Synaptic plasticity support Immune regulation	↓ pain perception Improved inflammatory pain control	2,5
Vitamin B ₁	Neurotransmitter synthesis Mitochondrial support ↓ oxidative stress	↓ pain severity Improved nerve function	2,5
Vitamin B ₆	↓ glutamate excitotoxicity Neurotransmitter synthesis (serotonin, GABA) Calcium channel modulation	↓ migraine symptoms (variable) Neuropathic pain modulation	2,5
Vitamin B ₁₂	Myelin synthesis & nerve repair ↓ inflammatory mediators Neurotrophic support	↓ neuropathic pain Improved nerve regeneration	2,3,5

GI: Glycemic Index; ROS: Reactive Oxygen Species; GABA: Gamma Aminobutyric Acid; NMDA: N-Methyl-D-Aspartate

Evidence levels were classified as follows: Level 1 = systematic reviews and meta-analyses; Level 2 = randomized controlled trials; Level 3 = cohort and case-control

studies; Level 4 = cross-sectional and observational studies; Level 5 = mechanistic, experimental, animal, or expert-opinion based evidence.

Conclusion and Recommendations

Chronic pain is a multifactorial clinical condition resulting from the interaction of biological, psychological, and lifestyle-related factors. An increasing body of evidence suggests that nutrition may contribute to the modulation of pain perception through mechanisms involving inflammation, oxidative stress, body weight regulation, and gut microbiota modulation. However, the current literature is heterogeneous, and the level of evidence regarding nutritional interventions varies across different approaches.

In the management of chronic pain, the adoption of a personalized and anti-inflammatory dietary approach is recommended. In particular, dietary patterns such as the Mediterranean diet, which is rich in fruits, vegetables, whole grains, and omega-3 fatty acids, stand out due to their potential anti-inflammatory and antioxidant effects. Conversely, limiting the intake of ultra-processed foods, refined sugars, trans and saturated fatty acids, while ensuring adequate consumption of low-glycemic-index carbohydrates, dietary fiber, and high biological value proteins, is important. In addition, clinical evaluation of deficiencies in vitamin D, magnesium, zinc, and B-complex vitamins should be considered, as they may contribute to pain-related symptoms in some individuals; however, routine high-dose supplementation is not currently recommended as a standard approach due to inconsistent evidence. Prebiotic and probiotic interventions may also contribute to the maintenance of gut microbiota balance and metabolic homeostasis. Nevertheless, the majority of the existing evidence is derived from observational studies, small-scale clinical trials, and selected patient populations. Therefore, although nutritional therapy represents a promising, low-risk, and cost-effective complementary approach in the management of chronic pain, larger-scale randomized controlled trials and high-quality systematic reviews are needed to establish causal relationships in individuals with chronic pain and to develop evidence-based nutritional recommendations.

REFERENCES

1. Treede RD, Rief W, Barke A, et al. Chronic pain as a symptom or a disease: The IASP classification of chronic pain for the international classification of diseases (ICD-11). *Pain*. 2019;160(1):19–27. doi: 10.1097/j.pain.0000000000001384.
2. Bautista A, Lee J, Delfino S, LaPreze D, Abd-Elsayed A. The impact of nutrition on pain: A narrative review of recent literature. *Curr Pain Headache Rep*. 2024;28(10):1059–66. doi: 10.1007/s11916-024-01275-x.

3. Zimmer Z, Fraser K, Grol-Prokopczyk H, Zajacova A. A global study of pain prevalence across 52 countries: Examining the role of country-level contextual factors. *Pain*. 2022;163(9):1740–50. doi: 10.1097/j.pain.0000000000002557.
4. Cohen SP, Vase L, Hooten WM. Chronic pain: An update on burden, best practices, and new advances. *Lancet*. 2021;397(10289):2082–97. doi: 10.1016/S0140-6736(21)00393-7.
5. Hadi MA, McHugh GA, Closs SJ. Impact of chronic pain on patients' quality of life: A comparative mixed-methods study. *J Patient Exp*. 2019;6(2):133–41. doi: 10.1177/2374373518786013.
6. Yong RJ, Mullins PM, Bhattacharyya N. Prevalence of chronic pain among adults in the United States. *Pain*. 2022;163(2):e328–32. doi: 10.1097/j.pain.0000000000002291.
7. Field R, Pourkazemi F, Hashempur MH, Thiruvengadam M, Rooney K. Editorial: Diet, nutrition, and functional foods for chronic pain. *Front Nutr*. 2024;11:1456706. doi: 10.3389/fnut.2024.1456706.
8. Cuomo A, Parascandolo I. Role of nutrition in the management of patients with chronic musculoskeletal pain. *J Pain Res*. 2024;17:2223–2238. doi: 10.2147/JPR.S456202.
9. Brain K, Burrows TL, Rollo ME, et al. A systematic review and meta-analysis of nutrition interventions for chronic noncancer pain. *J Hum Nutr Diet*. 2019;32(2):198–225. doi: 10.1111/jhn.12601.
10. Xu Lou I, Gil-García E, Cáceres-Matos R, Ali K, Molina E. Nutritional aspects in chronic non-cancer pain: A systematic review. *Front Nutr*. 2022;9:931090. doi: 10.3389/fnut.2022.931090.
11. Galvez-Sánchez CM, Montoro CI. Chronic pain: Clinical updates and perspectives. *J Clin Med*. 2022;11(12):3474. doi: 10.3390/jcm11123474.
12. Elma Ö, Tümkaya Yılmaz S, Deliëns T, et al. Do nutritional factors interact with chronic musculoskeletal pain? A systematic review. *J Clin Med*. 2020;9(3):702. doi: 10.3390/jcm9030702.
13. Elma Ö, Brain K, Dong H-J. The importance of nutrition as a lifestyle factor in chronic pain management: A narrative review. *J Clin Med*. 2022;11(19):5950. doi: 10.3390/jcm11195950.
14. Reddy VP. Oxidative stress in health and disease. *Biomedicines*, 2023;11(11):2925. doi: 10.3390/biomedicines11112925.

15. Aleksandrova K, Koelman L, Rodrigues CE. Dietary patterns and biomarkers of oxidative stress and inflammation: A systematic review of observational and intervention studies. *Redox biol.* 2021;42:101869. doi: 10.1016/j.redox.2021.101869.
16. Ho T, Ryan M, Holle J. Redox reactions in chronic pain: Mechanisms and relevance in fibromyalgia. *Front Pain Res (Lausanne).* 2025;6, 1593908. doi: 10.3389/fpain.2025.1593908.
17. Neyal M, Yimenicioglu F, Aydeniz A, et al. Plasma nitrite levels, total antioxidant status, total oxidant status, and oxidative stress index in patients with tension-type headache and fibromyalgia. *Clin Neurol Neurosur.* 2013;115(6):736–40. doi: 10.1016/j.clineuro.2012.08.028.
18. Cordero MD, Cotán D, del-Pozo-Martín Y, et al. Oral coenzyme Q10 supplementation improves clinical symptoms and recovers pathologic alterations in blood mononuclear cells in a fibromyalgia patient. *Nutrition.* 2012;28(11–12):1200–3. doi: 10.1016/j.nut.2012.03.018.
19. Schell J, Hal Scofield R, Barrett JR, et al. Strawberries improve pain and inflammation in obese adults with radiographic evidence of knee osteoarthritis. *Nutrients.* 2017;9(9):949. doi: 10.3390/nu9090949.
20. Ward SJ, Coates AM, Baldock KL, Stanford TE, Hill AM. Better diet quality is associated with reduced body pain in adults regardless of adiposity: Findings from the Whyalla Intergenerational Study of Health. *Nutr Res.* 2024;130:22–33. doi: 10.1016/j.nutres.2024.08.002.
21. Macphail K. C-reactive protein, chronic low back pain and, diet and lifestyle. *Int Musculoskelet Med.* 2015;37(1):29–32. doi: 10.1179/53615415Y.0000000001.
22. Jönsson M, Bäckryd E, Jonasson L, Gerdle B, Ghafouri B. Differences in plasma lipoprotein profiles between patients with chronic peripheral neuropathic pain and healthy controls: An exploratory pilot study. *Pain Rep.* 2022;7(5):e1036. doi: 10.1097/PR9.0000000000001036.
23. Calcutt NA. Diabetic neuropathy and neuropathic pain: A (CoN) fusion of pathogenic mechanisms? *Pain.* 2020;161(Suppl 1):S65-S86. doi: 10.1097/j.pain.0000000000001922.
24. Elma Ö, Lebuf E, Marnef AQ, et al. Diet can exert both analgesic and pronociceptive effects in acute and chronic pain models: A systematic review of preclinical studies. *Nutr Neurosci.* 2022;25(10):2195–2217. doi: 10.1080/1028415X.2021.1934956.
25. Pak R, Cho M, Pride K, Abd-Elsayed A. The gut microbiota and chronic pain. *Curr Pain Headache Rep.* 2024;28(4):259–69. doi: 10.1007/s11916-024-01221-x.

26. Santoni M, Miccini F, Battelli N. Gut microbiota, immunity and pain. *Immunol Lett.* 2021;229:44–47. doi: 10.1016/j.imlet.2020.11.010.
27. Nijs J, Tumkaya Yilmaz S, Elma Ö, et al. Nutritional intervention in chronic pain: An innovative way of targeting central nervous system sensitization? *Expert Opin Ther Targets.* 2020;24(8):793–803. doi: 10.1080/14728222.2020.1784142.
28. Glick-Bauer M, Yeh M-C. The health advantage of a vegan diet: Exploring the gut microbiota connection. *Nutrients.* 2014;6(11):4822–38. doi: 10.3390/nu6114822.
29. Goudman L, Demuyser T, Pilitsis JG, et al. Gut dysbiosis in patients with chronic pain: A systematic review and meta-analysis. *Front Immunol.* 2024;15:1342833. doi: 10.3389/fimmu.2024.1342833.
30. Nijs J, Leysen L, Vanlauwe J, et al. Treatment of central sensitization in patients with chronic pain: Time for change? *Expert Opin Pharmacother.* 2019;20(16):1961-70. doi: 10.1080/14656566.2019.1647166.
31. Cassani E, Privitera G, Pezzoli G, et al. Use of probiotics for the treatment of constipation in Parkinson's disease patients. *Minerva Gastroenterol Dietol.* 2011;57(2):117-121.
32. Roman P, Estévez AF, Miras A, et al. A pilot randomized controlled trial to explore cognitive and emotional effects of probiotics in fibromyalgia. *Sci Rep.* 2018;8(1):10965. doi: 10.1038/s41598-018-29388-5.
33. Okifuji A, Hare BD. The association between chronic pain and obesity. *J Pain Res.* 2015; 8:399–408. doi: 10.2147/JPR.S55598.
34. Brain K, Burrows TL, Bruggink L, et al. Diet and chronic non-cancer pain: The state of the art and future directions. *J Clin Med.* 2021;10(21):5203. doi: 10.3390/jcm10215203.
35. Elma Ö, Yilmaz ST, Deliëns T, et al. Chronic musculoskeletal pain and nutrition: Where are we and where are we heading? *PM R.* 2020;12(12):1268–1278. doi: 10.1002/pmrj.12346.
36. Dong H-J, Larsson B, Fischer MR, Gerdle B. Facing obesity in pain rehabilitation clinics: Profiles of physical activity in patients with chronic pain and obesity-A study from the Swedish Quality Registry for Pain Rehabilitation (SQRP). *PLoS One.* 2020;15(9): e0239818. doi: 10.1371/journal.pone.0239818.
37. Brain K, Burrows T, Rollo ME, Hayes C, Hodson FJ, Collins CE. Population characteristics in a tertiary pain service cohort experiencing chronic non-cancer pain: Weight status, comorbidities, and patient goals. *Healthcare (Basel).* 2017;5(2):28. doi: 10.3390/healthcare5020028.

38. Gota CE, Kaouk S, Wilke WS. Fibromyalgia and obesity: The association between body mass index and disability, depression, history of abuse, medications, and comorbidities. *J Clin Rheumatol*. 2015;21(6):289–95. doi: 10.1097/RHU.0000000000000278.
39. Atzeni F, Alciati A, Salaffi F, et al. The association between body mass index and fibromyalgia severity: Data from a cross-sectional survey of 2339 patients. *Rheumatol Adv Pract*. 2021;5(1):rkab015. doi: 10.1093/rap/rkab015.
40. Robson EK, Hodder RK, Kamper SJ, et al. Effectiveness of weight-loss interventions for reducing pain and disability in people with common musculoskeletal disorders: A systematic review with meta-analysis. *J Orhop Sports Phy Ther*. 2020;50(6):319-333. doi: 10.2519/jospt.2020.9041.
41. Geha P, deAraujo I, Green B, Small DM. Decreased food pleasure and disrupted satiety signals in chronic low back pain. *Pain*. 2014;155(4):712–722. doi: 10.1016/j.pain.2013.12.027.
42. Raja SN, Carr DB, Cohen M, et al. The Revised IASP definition of pain: Concepts, challenges, and compromises. *Pain*. 2021;161(9):1976–82. doi: 10.1097/j.pain.0000000000001939.
43. Yesildemir O, Guldaz M, Boqué N, et al. Adherence to the Mediterranean diet among families from four countries in the Mediterranean basin. *Nutrients*. 2025;17(7):1157.
44. Alaifi NS, Chan YM, Waly MI, Chin YS, Yusof BNM, Ahmad N. Application of mediterranean diet in cardiovascular diseases and type 2 diabetes mellitus: Motivations and challenges. *Nutrients*. 2022;14(13):2777. doi: 10.3390/nu14132777.
45. Perna S, Alalwan TA, Al-Thawadi S, et al. Evidence-based role of nutrients and antioxidants for chronic pain management in musculoskeletal frailty and sarcopenia in aging. *Geriatrics (Basel)*. 2020;5(1):16. doi: 10.3390/geriatrics5010016.
46. Batista ED, Andretta A, De Miranda RC, Nehring J, Paiva E dos S, Schieferdecker MEM. Food intake assessment and quality of life in women with fibromyalgia. *Rev Bras Reumatol Engl Ed*. 2016;56(2):105–110. doi: 10.1016/j.rbre.2015.08.015.
47. Santos HO, Macedo RCO. Impact of intermittent fasting on the lipid profile: Assessment associated with diet and weight loss. *Clin Nutr ESPEN*. 2018;24:14–21. doi: 10.1016/j.clnesp.2018.01.002.
48. Taskinen MR, Packard CJ, Borén J. Dietary fructose and the metabolic syndrome. *Nutrients*. 2019;11(9):1987. doi: 10.3390/nu11091987.

49. Sanders AE, Weatherspoon ED, Ehrmann BM, et al. Circulating polyunsaturated fatty acids and pain intensity in five chronic pain conditions. *J Pain*. 2023;24(3):478-489. doi: 10.1016/j.jpain.2022.10.008.
50. Walsh TP, Arnoid JB, Evans AM, Yaxley A, Damarell RA, Shanahan EM. The association between body fat and musculoskeletal pain: A systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2018;19(1):233. doi: 10.1186/s12891-018-2137-0.
51. Soares A de A, Louçana PMC, Nasi EP, Sousa KM de H, Sá OM de S, Silva-Néto RP. A double-blind, randomized, and placebo-controlled clinical trial with omega-3 polyunsaturated fatty acids (OPFA ω -3) for the prevention of migraine in chronic migraine patients using amitriptyline. *Nutr Neurosci*. 2018;21(3):219–223. doi: 10.1080/1028415X.2016.1266133.
52. Philpot U, Johnson MI. Diet therapy in the management of chronic pain: Better diet less pain? *Pain Manag*. 2019;9(4):335-338. doi: 10.2217/pmt-2019-0014.
53. von Känel R, Müller-Hartmannsgruber V, Kokinogenis G, Egloff N. Vitamin D and central hypersensitivity in patients with chronic pain. *Pain Med*. 2014;15(9):1609-1618. doi: 10.1111/pme.12454.
54. Xiaohua G, Dongdong L, Xiaoting N, et al. Severe vitamin D deficiency is associated with increased expression of inflammatory cytokines in painful diabetic peripheral neuropathy. *Front Nutr*. 2021; 8:612068. doi: 10.3389/fnut.2021.612068.
55. Moini A, Ebrahimi T, Shirzad N, et al. The effect of vitamin D on primary dysmenorrhea with vitamin D deficiency: A randomized double-blind controlled clinical trial. *Gynecol Endocrinol*. 2016;32(6):502–5. doi: 10.3109/09513590.2015.1136617.
56. Zarei S, Mohammad-Alizadeh-Charandabi S, Mirghafourvand M, Javadzadeh Y, Effati-Daryani F. Effects of calcium-vitamin D and calcium-alone on pain intensity and menstrual blood loss in women with primary dysmenorrhea: A randomized controlled trial. *Pain Med*. 2017;18(1):3–13. doi: 10.1093/pm/pnw121.
57. Konarska A, Fabijanski A, Dukacz A, et al. Magnesium in pain control - mechanisms of action in perioperative pain , neuropathic pain and migraine. *J Educ Health Sport*. 2025; 78: 57571-57571. doi: 10.12775/JEHS.2025.78.57571.
58. Srebro D, Vuckovic S, Milovanovic A, Kosutic J, Vujovic KS, Prostran M. Magnesium in Pain Research: State of the Art. *Curr Med Chem*. 2017;24(4):424–434. doi: 10.2174/0929867323666161213101744.

59. Oh TK, Chung SH, Park J, et al. Effects of perioperative magnesium sulfate administration on postoperative chronic knee pain in patients undergoing total knee arthroplasty: A retrospective evaluation. *J Clin Med*. 2019;8(12):2231. doi: 10.3390/jcm8122231.
60. Jiang Y-G, Wang Y-H, Zhang H, Wang Z-Y, Liu Y-Q. Effects of early-life zinc deficiency on learning and memory in offspring and the changes in DNA methylation patterns. *Nutr Neurosci*. 2022;25(5):1001-1010. doi: 10.1080/1028415X.2020.1831259.
61. Bagianto H. The influence of zinc deficiency on chronic pain in Sprague Dawley rats. *Med J Indones*. 2010;19(2):88–95. doi: 10.13181/mji.v19i2.388.
62. Teimoori B, Ghasemi M, Hoseini ZSA, Razavi M. The efficacy of zinc administration in the treatment of primary dysmenorrhea. *Oman Med J*. 2016;31(2):107–11. doi: 10.5001/omj.2016.21.
63. Mrowicka M, Mrowicki J, Dragan G, Majsterek I. The importance of thiamine (vitamin B₁) in humans. *Biosci Rep*. 2023;43(10): BSR20230374. doi: 10.1042/BSR20230374.
64. Costantini A, Pala MI, Tundo S, Matteucci P. High-dose thiamine improves the symptoms of fibromyalgia. *BMJ Case Rep*. 2013;bcr2013009019. doi: 10.1136/bcr-2013-009019.
65. Hosseini A, Alinejad V, Alinejad M, Aghakhani N. The effects of fish oil capsules and vitamin B₁ tablets on duration and severity of dysmenorrhea in students of high school in Urmia-Iran. *Glob J Health Sci*. 2014;6(7):124-9. doi: 10.5539/gjhs.v6n7p124.
66. Paez-Hurtado AM, Calderon-Ospina CA, Nava-Mesa MO. Mechanisms of action of vitamin B₁ (thiamine), B₆ (pyridoxine), and B₁₂ (cobalamin) in pain: A narrative review. *Nutr Neurosci*. 2023;26(3):235-253. doi: 10.1080/1028415X.2022.2034242.
67. Sadeghi O, Nasiri M, Maghsoudi Z, Pahlavani N, Rezaie M, Askari G. Effects of pyridoxine supplementation on severity, frequency and duration of migraine attacks in migraine patients with aura: A double-blind randomized clinical trial study in Iran. *Iran J Neurol* 2015;14(2):74–80.
68. Ghavidel-Parsa B, Naeimi A, Gharibpoor F, et al. Effect of vitamin B₆ on pain, disease severity, and psychological profile of fibromyalgia patients; a randomized, double-blinded clinical trial. *BMC Musculoskelet Disord*. 2022;23(1):664. doi: 10.1186/s12891-022-05637-7.
69. Suzuki K, Tanaka H, Ebara M, et al. Electrospun nanofiber sheets incorporating methylcobalamin promote nerve regeneration and functional recovery in a rat

sciatic nerve crush injury model. *Acta Biomat.* 2017; 53: 250-259. doi: 10.1016/j.actbio.2017.02.004.

70. Alvarado AM, Navarro SA. Complex B vitamins: Physiology and therapeutic effect on pain. *Am J Pharmacol Sci.* 2016;4(2):20–7. doi: 10.12691/ajps-4-2-2.
71. Ayanoğlu M, Tuhan H, Komüroğlu A, Tosun A. Is There a relation between vitamin b12 levels and headaches in children and adolescents? *J Behcet Uz Child Hosp.* 2021;11(1):73–9. doi: 10.5222/buchd.2021.32767.
72. Didangelos T, Karlafti E, Kotzakioulafi E, et al. Vitamin B12 supplementation in diabetic neuropathy: A 1-year, randomized, double-blind, placebo-controlled trial. *Nutrients*, 2021;13(2), 395. doi: 10.3390/nu13020395.
73. Schloss JM, Colosimo M, Airey C, Masci P, Linnane AW, Vitetta L. A randomised, placebo-controlled trial assessing the efficacy of an oral B group vitamin in preventing the development of chemotherapy-induced peripheral neuropathy (CIPN). *Support Care Cancer.* 2017;25(1):195–204. doi: 10.1007/s00520-016-3404-y.

The Role of Telerehabilitation-Based Exercises in the Management of Knee Osteoarthritis: A Narrative Review*

Yaşar Sinan KAYA**, Hüsnüye Merve DEMİRER***

Abstract

Knee osteoarthritis (KOA) is a progressive disease characterized by joint cartilage degeneration, with prevalence increasing with age. This condition causes pain and reduces quality of life. Traditional face-to-face rehabilitation may be limited by geographical and financial barriers. Telerehabilitation (TR) has emerged as a modern therapy method using digital platforms for remote exercise monitoring. This narrative review was conducted by searching PubMed and Google Scholar databases for studies published between 2010 and 2026 using keywords such as "knee osteoarthritis" and "telerehabilitation". Studies have shown that TR exercises may lead to reduced pain and improved joint function and quality of life. In conclusion, TR offers an effective treatment alternative, especially for those facing barriers to in-person care.

Keywords: Knee osteoarthritis, telerehabilitation, exercise therapy, remote rehabilitation, physical therapy modalities.

Diz Osteoartriti Yönetiminde Telerehabilitasyon Yoluyla Uygulanan Egzersizlerin Rolü: Bir Anlatı İncelemesi

Öz

Diz osteoartriti (KOA), eklem kıkırdığının dejenerasyonu ile karakterize ilerleyici bir hastalıktır. Bu durum, ağrıya neden olur ve yaşam kalitesini düşürür. Geleneksel yüz yüze rehabilitasyon, coğrafi ve finansal engeller nedeniyle kısıtlanabilir. Telerehabilitasyon (TR), dijital platformlar aracılığıyla uzaktan egzersiz takibi sağlayan modern bir yöntemdir. Bu anlatı incelemesi, 2010-2026 yılları arasında PubMed ve Google Scholar veri tabanlarında “diz osteoartriti” ve “telerehabilitasyon” anahtar kelimeleri kullanılarak yapılan taramalarla hazırlanmıştır. Araştırmalar, TR'nin ağrıyı azaltmaya ve fonksiyonları ve yaşam kalitesini iyileştirmeye yol açabileceğini göstermiştir. Sonuç olarak TR, yüz yüze tedaviye erişimde zorluk yaşayan bireyler için umut vadeden bir alternatiftir.

Anahtar Sözcükler: Diz osteoartriti, telerehabilitasyon, egzersiz tedavisi, uzaktan rehabilitasyon, fiziksel terapi modaliteleri.

Derleme Makale (Review Article)

Geliş / Received: 27.06.2025 & **Kabul / Accepted:** 12.08.2026

DOI: <https://doi.org/10.38079/igusabder.1728680>

* This study has been derived from the master's term project titled “Diz osteoartriti bireylerde telerehabilitasyon yoluyla uygulanan egzersizlerin etkisi”, which was accepted in 2025 at Istanbul Gelisim University, Institute of Graduate Studies, Department of Physical Therapy and Rehabilitation (Master) (Non Thesis) and prepared by Yaşar Sinan KAYA under the consultancy of Asst. Prof. Hüsnüye Merve DEMİRER.

** Physiotherapist, Istanbul Gelisim University, Institute of Graduate Studies, Physical Therapy and Rehabilitation (Master) Program, Istanbul, Türkiye. E-mail: fzt.sinankaya@gmail.com [ORCID https://orcid.org/0009-0009-9385-0066](https://orcid.org/0009-0009-9385-0066)

*** Asst. Prof. Dr., Istanbul Gelisim University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: hmyilmaz@gelisim.edu.tr [ORCID https://orcid.org/0000-0003-2999-1461](https://orcid.org/0000-0003-2999-1461)

Introduction

Osteoarthritis (OA) is a chronic and progressive disease resulting in joint degeneration¹⁻². Knee osteoarthritis (KOA) is the most common form, affecting an estimated 240 million people globally². KOA is a significant health issue associated with pain, physical disability, and early mortality in developed countries, leading to substantial increases in economic costs³.

Telerehabilitation (TR) provides remote access to rehabilitation via telecommunication technology. TR provides synchronous or asynchronous access to the rehabilitation environment for healthcare professionals and patients through telephone, videoconferencing, and video recordings⁴. Exercise is one of the fundamental components of OA treatment. Especially in cases of KOA, exercises aimed at strengthening muscles, improving joint mobility, and increasing functional capacity can reduce pain, enhance joint function, and improve quality of life. However, ensuring that patients exercise regularly can be challenging due to physical limitations, geographical distances, or time constraints. At this point, TR can help individuals overcome these challenges by enabling them to follow their exercise programs in a guided manner. TR is considered to have the potential to be a long-term, sustainable treatment method for individuals with OA⁵.

The aim of this study, conducted as a narrative review, is to investigate the effects of exercises delivered through TR on pain, functional capacity, mobility, and quality of life in individuals diagnosed with KOA and to compare their effectiveness with that of traditional face-to-face physiotherapy.

Material and Methods

This study was designed as a narrative review to evaluate the clinical effectiveness of TR in the management of KOA.

Search Strategy

A comprehensive literature search was performed in electronic databases, including PubMed and Google Scholar. The search criteria focused on peer-reviewed articles published in English and Turkish. Keywords used were “knee osteoarthritis,” “telerehabilitation,” and “exercise therapy.” Studies published between 2010 and 2026 that compared TR with face-to-face interventions or evaluated cost-effectiveness were prioritized.

Study Selection Process

Articles were selected based on the following criteria: (1) peer-reviewed original research or systematic reviews; (2) a focus on adult participants (typically aged 40–80 years) diagnosed with KOA; and (3) interventions comparing TR—delivered synchronously or asynchronously via phone, video, or sensor-based systems—with traditional face-to-face

physiotherapy. Priority was given to randomized controlled trials (RCTs) and systematic reviews that reported outcomes for pain, functional capacity, mobility, and quality of life.

Synthesis Approach

Gathered data were analyzed using a qualitative synthesis approach, categorizing the evidence based on clinical efficacy (comparable effectiveness to usual care), operational protocols (frequency and duration), and cost-effectiveness.

Osteoarthritis

According to the definition of the Osteoarthritis Research Society International (OARSI), OA is a chronic degenerative inflammatory disease that begins with abnormal joint tissue metabolism and progresses to anatomical and/or physiological irregularities in the joint. Recent evidence suggests that OA involves not only the mechanical degeneration of articular cartilage but also structural and functional changes in several joint components, including subchondral bone, meniscus, synovium, and periarticular ligaments².

Patients with OA primarily complain of pain and stiffness in the affected joint or joints⁶. Pain is the most prominent symptom in OA, and 20% of chronic pain cases in Europe are associated with OA^{7,8}. While pain in the early stages of the disease is activity-related, in the chronic stage its causes and timing become unpredictable⁶. It has been shown that long-term chronic pain in OA has negative effects on psychological health, sleep, and social participation^{9,10}. Stiffness becomes more noticeable in the morning and after prolonged periods of rest during the day but typically resolves within 30 minutes⁶. Increased mechanical load due to cartilage–subchondral bone loss and degeneration of supporting structures may lead to bone misalignment or growth abnormalities^{11,12}. Varus–valgus malalignments of the knee are frequently observed in OA¹³.

Epidemiology and Global Impact

OA leads to functional loss and a reduction in activities¹⁴. In a study involving 10,000 patients, 81.5% of individuals with OA reported limitations in daily living activities; 61.1% experienced restricted mobility outside the home, and 12.8% had limited movement even within the home¹⁵. Decreased range of motion, crepitus, effusion, and, in advanced stages, muscle atrophy may also be observed^{12,16}. All of these symptoms, along with chronic pain, reduce the patient's social participation and quality of life⁶.

OA leads to significant workforce losses and high medical care costs. In the United States, OA-related cost losses amount to \$65 billion, while direct medical costs exceed \$100 billion. Additionally, it is known that an individual incurs a total of \$15,000 in medical expenses over their lifetime due to OA¹⁷.

Globally, symptomatic OA (typically affecting the hip and knee) is estimated to affect approximately 240 million people². A meta-analysis conducted in China, including 74,908 participants across 21 studies, reported an overall prevalence of 14.6% for OA,

with prevalence increasing with age. The study also found that the prevalence of OA was higher in women (19.1%) compared to men (10.9%)¹⁸. Similarly, a demographic study conducted in Korea with 12,287 participants found that the prevalence of radiographic OA among individuals aged 50 and above was as high as 35.1%, with the prevalence being higher in women compared to men¹⁹.

Regional studies report varying prevalence rates for KOA, but these figures must be interpreted according to their diagnostic criteria. In Türkiye, the prevalence of symptomatic KOA was reported as 20.9% among individuals aged 40 and above²⁰. Another study reported a symptomatic KOA prevalence of 22.5% in women and 8% in men²¹. The discrepancy between these values is attributed to methodological differences, such as the age inclusion criteria. Similarly, a comprehensive meta-analysis in China identified an overall symptomatic prevalence of 14.6%¹⁸. In contrast, the Korea National Health and Nutrition Examination Survey indicated a much higher prevalence of 35.1% because it recorded radiographic OA, which identifies structural joint changes regardless of the presence of clinical symptoms¹⁹.

Studies have investigated the risk factors for OA and have found consistent associations with factors such as age, gender, body weight changes and obesity, history of injury, occupational physical demands, physical activity, joint malalignment, muscle strength around the joint, lifestyle, geographic regions, and genetics^{11,22}. Due to the decreasing levels of physical activity, increasing prevalence of obesity, and longer life expectancy, it is expected that the frequency of OA will rise in the coming years¹⁸.

Treatment Methods

In patients with KOA, the goals are to control symptoms, prevent the progression of joint damage, improve quality of life, and increase the level of functional independence. Factors such as age, physical condition, comorbidities, severity of symptoms, patient preferences, and treatment costs should be considered when determining treatment options. Treatment consists of non-pharmacological (conservative), pharmacological, and surgical methods when necessary. An individualized treatment plan should be created for each patient²³.

Among conservative treatments, physiotherapy, which includes structured exercise programs, is considered a fundamental component in the management of KOA². Physiotherapy applications include physical therapy agents such as laser, ultrasound, electrotherapy, heat and cold applications, and exercise programs²⁴. Research consistently supports the role of physiotherapy in improving joint function, reducing pain, and enhancing overall quality of life²⁵.

However, access to traditional face-to-face rehabilitation is often limited due to barriers such as geographic location, financial constraints, and mobility limitations, preventing many patients from receiving the necessary care²⁶. In response to these challenges, TR has emerged as an alternative, utilizing digital technologies to deliver rehabilitation programs remotely.

Telerehabilitation

TR is the provision of rehabilitation services to patients in remote locations using information and communication technologies²⁷. TR employs various technologies, including virtual reality, mobile applications, artificial intelligence, tablets, mobile games, online video conferences, and other methods to deliver rehabilitation services²⁸. TR has been applied in cardiac rehabilitation, cancer rehabilitation, neurological rehabilitation, spinal cord injuries, musculoskeletal disorders, and depression treatment²⁹.

TR encompasses a wide range of services, including guided exercise programs, educational resources, and real-time feedback from healthcare providers via telecommunication platforms³⁰. This approach offers various advantages, such as increased accessibility, convenience, and the provision of continuous, personalized care, which are particularly beneficial for chronic conditions like KOA³¹. Additionally, TR enables healthcare providers to monitor patient progress and adjust treatment plans accordingly, thereby delivering a more individualized treatment experience³². The successful implementation of TR depends on patients' access to telecommunication technology and their familiarity with its use. Therefore, TR outcomes may vary based on country and socioeconomic status³³.

Advantages and Disadvantages of Telerehabilitation

Advantages provided by TR include reducing hospitalization rates and preventing readmissions, enabling early discharge from rehabilitation units, lowering costs and saving time, providing rapid access to outpatient rehabilitation services, allowing flexible planning of the intensity, frequency, and duration of rehabilitation programs according to patient needs, controlling costs, reducing waiting lists, and ensuring sufficient and continuous service delivery in both acute (e.g., postoperative) and chronic (e.g., degenerative diseases) conditions. Additionally, supporting early return to work and improving health outcomes and quality of life are other significant contributions³⁴.

TR also has some disadvantages. The inability to perform palpation and other special tests used as diagnostic tools during clinical examination may limit the assessments conducted with this method. Therefore, especially in complex clinical cases, it is preferred that the initial evaluation session be conducted face-to-face, taking into account past clinical findings. Additionally, access to rehabilitation equipment such as elastic bands, balls, and weights is limited in TR services. This situation poses a disadvantage in planning the rehabilitation program. To address such limitations, physiotherapists may need to identify the necessary equipment for participation in therapeutic exercises in advance and have these tools delivered to the patient's home. Furthermore, certain elements of the clinical environment are lacking in TR. To compensate for these deficiencies, verbal communication (explanations, clear instructions, and supportive expressions) and body language (positive nodding, eye contact, etc.) must be used effectively³³.

TR reduces costs, saves time, and increases accessibility. However, the inability to perform palpation and the lack of clinical equipment at home are significant disadvantages.

Cost-Effectiveness of Telerehabilitation

As a newly developing field, there is a need to conduct cost analysis as well as evaluate clinical outcomes related to TR³⁵. The cost of TR interventions includes the cost of technological devices such as smartphones or computers, the internet service required for communication, and the cost of the professional services provided³⁶. The cost of traditional face-to-face rehabilitation interventions includes the cost of the professional services provided, the travel expenses of the patient and their caregiver, and other costs³⁷. It is evident that increasing the distance between the patient's residence and the rehabilitation center raises the cost of traditional rehabilitation interventions. When the patient's distance to the rehabilitation center exceeds 30 kilometers, the cost differential between traditional rehabilitation and TR increases by 18%, and when the distance reaches 50 kilometers, this increase rises to 123%. From this perspective, saving time and money spent on travel may allow for an increase in the budget allocated for rehabilitation services. Therefore, considering cost-effectiveness in appropriate patient selection for TR would be beneficial³⁸.

Discussion

Telerehabilitation-Based Exercises in the Management of KOA

TR systems include video conference-based, sensor-based, and virtual reality-based technologies³⁹.

Video conference-based TR is a way to connect the clinician and the patient for a clinical purpose consisting of assessment and/or treatment, allowing the patient to exercise at home under the real-time supervision of a physiotherapist⁴⁰. It is a basic TR system based on image and sound transmission between the physiotherapist and the patient^{39,41,42}.

Sensor-based TR is somewhat more complex than video conference-based TR. In this system, wearable devices equipped with sensors such as inclinometer sensors, accelerometers, and gyroscopes are used to assess the patient's movements. Additionally, activity tracking devices that do not require the patient to wear them (such as Nintendo Wii Remote®, Leap Motion®, or Kinect®) and robotic devices are also used^{39,41,42}.

Virtual reality-based TR systems utilize computer-generated three-dimensional virtual environments that can be configured by the patient to elicit specific movements and motor responses⁴². Through intermediary devices, the computer makes changes in the virtual graphical environment based on the user's actions (voice input, movement, etc.). Thus, it creates the illusion of the user's interaction and intervention within the virtual reality⁴²⁻⁴⁴. When reviewing the literature, it has been observed that TR applications in patients with KOA mostly involve video conference-based TR.

In a study conducted by Aily et al. in 2023, 100 adult participants with KOA underwent circuit training lasting 25-45 minutes, three times a week for 14 weeks. The participants, randomly divided into two groups, were given the same exercise program either through TR (remote video recordings + telephone follow-up) or face-to-face. This study found TR to be as effective as face-to-face circuit training for pain and muscle strength. However, from a critical perspective, the researchers noted that the asynchronous model inherently allows for less interaction between the clinician and the patient compared to synchronous models. Furthermore, while adherence was high, the TR group's data relied on self-reported diaries, which may be prone to overestimation of actual exercise compliance⁴⁵.

In their study with 48 individuals diagnosed with KOA, Kim et al. provided participants with exercise programs either through face-to-face visits or remotely via TR for eight weeks in randomly assigned groups. The study found that participants in both the face-to-face and TR exercise programs showed improvements in walking speed, knee function, and health-related quality of life. There was no significant difference between the TR exercise group and the face-to-face exercise group in improving knee joint function and health-related quality of life; however, the face-to-face group demonstrated a significantly greater increase in gait speed compared to the TR group. Based on these findings, it was emphasized that TR exercise programs for patients with KOA can complement face-to-face exercise programs, highlighting that TR should be used not only as an alternative complementary program but also as an intervention method for various diseases⁴⁶.

Another study examined the effectiveness of a 4-week supervised TR program delivered via video calls compared to conventional rehabilitation. The findings indicated that TR is a valid and effective alternative to conventional therapy for reducing pain and improving functional scores. Nevertheless, several methodological limitations must be considered: the study had a relatively small sample size (n=55) and a short follow-up period of only three months, which limits the ability to assess the long-term sustainability of the results. Additionally, the TR group was found to be significantly more physically active at baseline than the control group, which may have introduced a selection bias regarding treatment adherence and outcomes⁴⁷.

As a result of a systematic review and meta-analysis investigating the effectiveness of different TR applications in the treatment of OA, it was found that internet-based rehabilitation is a promising strategy for patients with KOA. Compared to conventional rehabilitation, it may improve pain in KOA patients but does not enhance physical function. Additionally, TR was found to be beneficial for delivering home-based rehabilitation exercises in patients with KOA, thereby reducing the economic burden on healthcare. However, it was also noted that there is currently relatively limited research on the effects of TR on KOA³¹.

In a review study focusing on technologies and teleservices for TR in patients with KOA, it was emphasized that video-based TR programs can be considered the best alternative solution to conventional treatment. The study also showed that, due to rapid

advancements in sensor technologies in recent years, sensor-based solutions have been gaining increasing popularity. However, it was noted that communication and human-delivered feedback remain just as important as monitoring and intervention services³⁰.

Another systematic review also reported that TR is a promising alternative method, especially for KOA patients who face barriers in accessing face-to-face therapy. It was found to be effective in reducing pain and improving strength and balance; however, its success was noted to depend on patient engagement, the delivery of the intervention, and adherence to rehabilitation protocols. Additionally, it was emphasized that therapist-guided programs yield better outcomes compared to self-managed approaches⁴⁸.

The clinical efficacy of TR is further supported by a large-scale systematic review and meta-analysis conducted by Cottrell et al., which analyzed 13 studies involving 1,520 participants with various musculoskeletal conditions. This review provides compelling evidence that real-time (synchronous) TR is effective in improving physical function and reducing pain. Specifically, for populations following total knee arthroplasty -a condition closely related to advanced KOA- the meta-analysis demonstrated that TR is equivalent and not inferior to conventional face-to-face models of care. However, a nuanced finding of this synthesis is that while TR as a "stand-alone" treatment is comparable to face-to-face care, TR delivered in addition to usual care may yield even more favorable results for physical function⁴⁹.

The review highlights that while blinding of participants and clinicians is often impossible in these trials, this methodological limitation introduces a substantial risk of bias regarding the study's internal validity⁴⁹. Specifically, the lack of blinding can lead to overestimation of treatment effects or inflated self-reported outcomes. Nevertheless, the consistency of findings across various musculoskeletal conditions suggests that TR remains a viable clinical option, especially when blinded outcome assessors are utilized to mitigate these potential biases^{45,47,49}.

Comparative Efficacy: Telerehabilitation vs. Face-to-Face Treatment

While TR is broadly supported as a viable alternative, it is critical to note that face-to-face treatment may be superior in specific clinical parameters. For instance, Kim et al. found that while both TR and face-to-face groups improved, the face-to-face group demonstrated a significantly greater increase in gait speed compared to the TR group⁴⁶. This disparity is attributed to the therapist's ability to provide immediate physical touch and real-time manual corrections. Furthermore, a large-scale meta-analysis by Xiang et al. concluded that while TR effectively reduces pain, it may not improve physical function as effectively as conventional rehabilitation³¹. Furthermore, Kloeck et al. reported that while both methods are effective, reducing face-to-face sessions in a blended model does not necessarily yield superior functional outcomes compared to standard care⁵⁰.

Practical Implications

To maximize the effectiveness of TR in KOA management while acknowledging current evidence heterogeneity, the following practical considerations are suggested^{45,47,51-54}:

Disease Stage: TR appears to be the most effective for individuals in the early to moderate stages of KOA, specifically those classified as Kellgren-Lawrence (KL) grades I, II, or III.

Frequency and Duration: Successful protocols typically utilize a frequency of 3 sessions per week. The total duration for a significant clinical effect ranges from 4 to 14 weeks. Sessions should last between 20–25 minutes for focused exercise protocols and up to 45–60 minutes when including comprehensive education and warm-up components.

Telerehabilitation Method: While various models exist, synchronous video conferencing with direct physical therapist contact is often highlighted as among the most effective TR modalities for reducing pain and functional disability because it facilitates real-time professional supervision and immediate feedback.

Critical Discussion and Methodological Limitations

A critical synthesis of current research reveals several methodological limitations that impact the generalizability of TR findings.

Blinding: Due to the physical nature of exercise, blinding of participants and therapists is not possible, which introduces a substantial risk of performance and expectancy bias. While outcome assessors can be blinded, this was only achieved in roughly half of the reviewed trials^{47,49}.

Sample Size and Follow-up: Many studies are characterized by small sample sizes (e.g., n=48, to n=55), which may limit statistical power and the generalizability of results. Furthermore, short follow-up periods (typically 3–6 months) prevent a clear understanding of the long-term sustainability of TR outcomes^{28,47}.

Inter-study Heterogeneity: There is a very high degree of heterogeneity regarding technological platforms (e.g., Zoom, WhatsApp, specialized apps), exercise types, and patient baseline activity levels, making it difficult to establish a universal standard of care^{31,47}.

Reporting Bias: In asynchronous or self-managed models, adherence data often rely on self-reported diaries, which are prone to overestimation of actual compliance⁴⁵.

Conclusion and Suggestions

In conclusion, TR has increasingly been used and become a potentially cost-efficient tool in the management of KOA. Current literature suggests that TR is a viable and generally comparable alternative to face-to-face treatment, offering significant improvements in pain relief and patient-reported quality of life. However, it is essential to express these

findings with caution due to the high degree of inter-study heterogeneity regarding technological platforms and exercise types. Furthermore, TR may have limitations in improving specific motor functions, such as gait speed, where face-to-face interventions remain superior due to immediate manual feedback and physical contact. TR may offer a promising option in the management of KOA, especially for individuals who experience difficulties accessing in-person treatment. The use of multiple technologies in combination can make treatment more engaging, encourage patients to remain committed to the process, and enhance outcomes. While short-term outcomes are promising, the long-term sustainability of these benefits remains uncertain. Future research should focus on standardizing protocols and evaluating the long-term sustainability of these digital interventions.

REFERENCES

1. Esmer AF, Başarır K, Binnet M. Diz eklemine cerrahi anatomisi. *TOTBİD Dergisi*. 2011;10(1):38-44.
2. Katz JN, Arant KR, Loeser RF. Diagnosis and treatment of hip and knee osteoarthritis: A review. *JAMA*. 2021;325(6):568-578.
3. Luyten FP, Zeinstra-Zeinstra S, Dell'Accio F, et al. Toward classification criteria for early osteoarthritis of the knee. *Semin Arthritis Rheum*. 2018;47(4):457-463.
4. Hansen H, Bieler T, Beyer N, et al. COPD online rehabilitation versus conventional COPD rehabilitation—rationale and design for a multicenter randomized controlled trial study protocol (COPe trial). *BMC Pulm Med*. 2017;17(1):1-14.
5. Tousignant M, Moffet H, Boissy P, Corriveau H, Cabana F, Marquis F. A randomized controlled trial of home telerehabilitation for post-knee arthroplasty. *J Telemed Telecare*. 2011;17(4):195-198.
6. Jang S, Lee K, Ju JH. Recent updates of diagnosis, pathophysiology, and treatment on osteoarthritis of the knee. *Int J Mol Sci*. 2021;22(5):2619.
7. Dieppe PA, Lohmander LS. Pathogenesis and management of pain in osteoarthritis. *Lancet*. 2005;365(9463):965-973.
8. O'Brien T, Breivik H. The impact of chronic pain—European patients' perspective over 12 months. *Scand J Pain*. 2012;3(1):23-29.
9. Neogi T. The epidemiology and impact of pain in osteoarthritis. *Osteoarthritis Cartilage*. 2013;21(9):1145-1153.

10. Yu H, Huang T, Lu WW, Tong L, Chen D. Osteoarthritis pain. *Int J Mol Sci*. 2022;23(9):5072.
11. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. *Lancet*. 2019;393(10182):1745-1759. doi:10.1016/S0140-6736(19)30417-9.
12. Taruc-Uy RL, Lynch SA. Diagnosis and treatment of osteoarthritis. *Prim Care*. 2013;40(4):821-836.
13. Felson DT, McLaughlin S, Goggins J, et al. Bone marrow edema and its relation to progression of knee osteoarthritis. *Ann Intern Med*. 2003;139(5 Pt 1):330-336.
14. Hawker GA, Stewart L, French MR, et al. Understanding the pain experience in hip and knee osteoarthritis: An OARSI/OMERACT initiative. *Osteoarthritis Cartilage*. 2008;16(4):415-422.
15. Fautrel B, Hilliquin P, Rozenberg S, et al. Impact of osteoarthritis: Results of a nationwide survey of 10,000 patients consulting for OA. *Joint Bone Spine*. 2005;72(3):235-240.
16. Hinton R, Moody RL, Davis AW, Thomas SF. Osteoarthritis: Diagnosis and therapeutic considerations. *Am Fam Physician*. 2002;65(5):841-848.
17. Losina E, Paltiel AD, Weinstein AM, et al. Lifetime medical costs of knee osteoarthritis management in the United States: Impact of extending indications for total knee arthroplasty. *Arthritis Care Res (Hoboken)*. 2015;67(2):203-215.
18. Li D, Li S, Chen Q, Xie X. The prevalence of symptomatic knee osteoarthritis in relation to age, sex, area, region, and body mass index in China: A systematic review and meta-analysis. *Front Med (Lausanne)*. 2020;7:304.
19. Hong JW, Noh JH, Kim DJ. The prevalence of and demographic factors associated with radiographic knee osteoarthritis in Korean adults aged >50 years: The 2010-2013 Korea National Health and Nutrition Examination Survey. *PLoS One*. 2020;15(3):e0230613.
20. Yesil H, Hepguler S, Ozturk C, Capaci K, Yesil M. Prevalence of symptomatic knee, hand and hip osteoarthritis among individuals 40 years or older: A study conducted in İzmir city. *Acta Orthop Traumatol Turc*. 2013;47(4):231-235.
21. Kaçar C, Gilgil E, Urhan S. et al. The prevalence of symptomatic knee and distal interphalangeal joint osteoarthritis in the urban population of Antalya, Turkey. *Rheumatol Int*. 2005;25:201-204.
22. Bakırhan S, Bozan O, Unver B, Karatosun V. Evaluation of functional characteristics in patients with knee osteoarthritis. *Acta Ortop Bras*. 2017;25(6):248-252.

23. Alkan H, Ardıç F. *Güncel kılavuzlar eşliğinde osteoartritte non-farmakolojik tedavi*. In: Hepgüler AS, editor. Osteoartrit. 1st ed. Ankara: Türkiye Klinikleri; 2020. p.70-77.
24. Bijlsma JWJ, Berenbaum F, Lafeber FPJG. Osteoarthritis: An update with relevance for clinical practice. *Lancet*. 2011;377:2115-2126.
25. Kolasinski SL, Neogi T, Hochberg MC, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. *Arthritis Rheumatol*. 2020;72(2):220-233.
26. Odole AC, Ojo OD. A telephone-based physiotherapy intervention for patients with osteoarthritis of the knee. *Int J Telerehabil*. 2013;5(2):11-20.
27. Laver KE, Adey-Wakeling Z, Crotty M, et al. Telerehabilitation services for stroke. *Cochrane Database Syst Rev*. 2020;1(1):CD010255.
28. Mousavi Baigi SF, Kimiafar K, Ghaddaripouri K, et al. The effect of telerehabilitation on improving the physical activity of patients with osteoarthritis: A systematic review. *J Educ Health Promot*. 2023;12:408.
29. van Egmond MA, van der Schaaf M, Vredevelde T, et al. Effectiveness of physiotherapy with telerehabilitation in surgical patients: A systematic review and meta-analysis. *Physiotherapy*. 2018;104(3):277-298.
30. Naeemabadi M, Fazlali H, Najafi S, Dinesen B, Hansen J. Telerehabilitation for patients with knee osteoarthritis: A focused review of technologies and teleservices. *JMIR Biomed Eng*. 2020;5(1):e16991.
31. Xiang W, Wang JY, Ji BJ, Li LJ, Xiang H. Effectiveness of different telerehabilitation strategies on pain and physical function in patients with knee osteoarthritis: Systematic review and meta-analysis. *J Med Internet Res*. 2023;25:e40735.
32. Azma K, RezaSoltani Z, Rezaeimoghaddam F, Dadarkhah A, Mohsenolhosseini S. Efficacy of tele-rehabilitation compared with office-based physical therapy in patients with knee osteoarthritis: A randomized clinical trial. *J Telemed Telecare*. 2018;24(8):560-565.
33. Aily JB, Barton CJ, Mattiello SM, De Oliveira Silva D, De Noronha M. Telerehabilitation for knee osteoarthritis in Brazil: A feasibility study. *Int J Telerehabil*. 2020;12(2):137-148.
34. Turolla A, Rossetini G, Viceconti A, Palese A, Geri T. Musculoskeletal physical therapy during the COVID-19 pandemic: Is telerehabilitation the answer? *Phys Ther*. 2020;100(8):1260-1264.

35. Shenoy MP, Shenoy PD. Identifying the challenges and cost-effectiveness of telerehabilitation: A narrative review. *J Clin Diagn Res.* 2018;12(12):1-4.
36. Dávalos ME, French MT, Burdick AE, Simmons SC. Economic evaluation of telemedicine: Review of the literature and research guidelines for benefit-cost analysis. *Telemed J E Health.* 2009;15(10):933-948.
37. Kidholm K, Rasmussen MK, Andreassen JJ, et al. Cost-utility analysis of a cardiac telerehabilitation program: The Teledialog Project. *Telemed J E Health.* 2016;22(7):553-563.
38. Tousignant M, Moffet H, Nadeau S, et al. Cost analysis of in-home telerehabilitation for post-knee arthroplasty. *J Med Internet Res.* 2015;17(3):e83.
39. Aloyuni S, Alharbi R, Kashoo F, et al. Knowledge, attitude, and barriers to telerehabilitation-based physical therapy practice in Saudi Arabia. *Healthcare (Basel).* 2020;8(4).
40. Horsley S, Schock G, Grona SL, et al. Use of real-time videoconferencing to deliver physical therapy services: A scoping review of published and emerging evidence. *J Telemed Telecare.* 2019;26(10):581-589.
41. Anton D, Berges I, Bermúdez J, Goñi A, Illarramendi A. A telerehabilitation system for the selection, evaluation and remote management of therapies. *Sensors.* 2018;18(5):1459.
42. Russell TG. Physical rehabilitation using telemedicine. *J Telemed Telecare.* 2007;13(5):217-220.
43. Matijevic V, Secic A, Masic V, et al. Virtual reality in rehabilitation and therapy. *Acta Clin Croat.* 2013;52(4):453-457.
44. Jiang S, Xiang J, Gao X, Guo K, Liu B. The comparison of telerehabilitation and face-to-face rehabilitation after total knee arthroplasty: A systematic review and meta-analysis. *J Telemed Telecare.* 2018;24(4):257-262.
45. Aily JB, de Noronha M, Selistre LFA, Ferrari RJ, White DK, Mattiello SM. Face-to-face and telerehabilitation delivery of circuit training have similar benefits and acceptability in patients with knee osteoarthritis: A randomised trial. *J Physiother.* 2023;69(4):232-239.
46. Kim JY, Lee DW, Jeong MB. Effect of a telerehabilitation exercise program on the gait, knee function and quality of life in patients with knee osteoarthritis. *J Korean Soc Phys Med.* 2020;15(1):143-152.

47. Tedeschi R, Platano D, Pillastrini P, Berti L, Benedetti MG. Effectiveness of tele-rehabilitation in patients with knee osteoarthritis: A randomized controlled trial. *Digit Health*. 2024;10:20552076241286186.
48. Plavoukou T, Iosifidis M, Papagiannis G, Stasinopoulos D, Georgoudis G. The effectiveness of telerehabilitation in managing pain, strength, and balance in adult patients with knee osteoarthritis: Systematic review. *JMIR Rehabil Assist Technol*. 2025;12(1):e72466.
49. Cottrell MA, Galea OA, O'Leary SP, Hill AJ, Russell TG. Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: A systematic review and meta-analysis. *Clin Rehabil*. 2017; 31(5):625-638.
50. Kloeck CJ, Bossen D, Spreeuwenberg PM, Dekker J, de Bakker DH, Veenhof C. Effectiveness of a blended physical therapist intervention in people with hip osteoarthritis, knee osteoarthritis, or both: A cluster-randomized controlled trial. *Phys Ther*. 2018; 98, 560-70.
51. Tore NG, Oskay D, Haznedaroglu S. The quality of physiotherapy and rehabilitation program and the effect of telerehabilitation on patients with knee osteoarthritis. *Clinical Rheumatology*. 2023; 42(3), 903-915.
52. Plavoukou T, Kasnesis P, Syropoulou AC, Papagiannis G, Stasinopoulos D, Georgoudis G. Wearable sensor-based telerehabilitation versus conventional physiotherapy in knee OA: Insights from the KneE-PAD pilot study. *Appl Sci*. 2025; 15:12988.
53. Cai C, Tiang PG, Ng A, Xian Fei FN, Koh WL. An assessor-blinded randomized controlled trial comparing a tele-rehabilitation program with wearable technology to conventional face-to-face physiotherapy in patients with knee osteoarthritis. *Physiother Theory Pract*. 2026.
54. Kotnik P, Hussein M. Does physical therapist contact matter? A randomised controlled trial comparing telerehabilitation and booklet-based exercise for knee osteoarthritis. *Eur J Transl Myol*. 2026; 36(2):15253.

The Relationship of Temperament and Character with Substance Use

Ünal Erdem ELLİ*

Abstract

This review aims to synthesize the studies focusing on the relationship between the temperament and character dimensions of Cloninger's Temperament and Character Inventory and substance abuse. A literature search including research articles, meta-analysis, and longitudinal studies was conducted. The findings from the included studies suggest the temperament trait of Novelty Seeking emerging as a consistent risk factor for initiation and sustaining of use of multiple types of substances. Latest research also points to gender and substance type – specific differences in personality profiles of women with opioid addiction compared to women with alcohol addiction. The combination of high Novelty Seeking and low Harm Avoidance, predicts earlier onset substance abuse with relatively worse prognosis. Amongst character dimensions, low Self-Directedness emerges as an important factor to understand transition from substance use to addiction. Neurobiological evidence suggests overlapping neural circuits that modulate both personality traits and drug reward in the mesocorticolimbic dopamine system. In conclusion, TCI offers a strong framework to understand individual proneness, to identify at-risk populations, to individualize treatment approaches, and to predict treatment outcomes. The incorporation of personality assessment into clinical practice may have significant value for prevention and treatment of substance use disorders.

Keywords: Temperament and Character Inventory, TCI, substance use disorders, addiction, personality, novelty seeking.

Mizaç ve Karakter ile Madde Kullanımı İlişkisi

Öz

Bu derleme, Cloninger'in Mizaç ve Karakter Envanteri'nin (TCI) mizaç ve karakter boyutları ile madde kullanımı arasındaki ilişkiye odaklanan çalışmaları sentezlemeyi amaçlamaktadır. Araştırma makaleleri, meta-analizler ve boylamsal çalışmalar dahil olmak üzere bir literatür taraması gerçekleştirilmiştir. Dahil edilen çalışmalardan elde edilen bulgular, Yenilik Arayışı mizaç özelliğinin çeşitli türde maddelerin kullanımına başlama ve sürdürmede tutarlı bir risk faktörü olduğunu göstermektedir. Son araştırmalar ayrıca, opioid bağımlılığı olan kadınlarla alkol bağımlılığı olan kadınlar arasında cinsiyete ve madde türüne özgü kişilik profili farklılıklarını da ortaya koymaktadır. Yüksek Yenilik arayışı ile düşük Zarardan Kaçınma kombinasyonu, daha erken başlangıçlı madde kullanımını ve nispeten daha kötü prognozu öngörmektedir. Karakter boyutları arasında, düşük Kendini Yönetme, madde kullanımından bağımlılığa geçişi anlamak için önemli bir faktör olarak öne çıkmaktadır. Nörobiyolojik kanıtlar, hem kişilik özelliklerini hem de madde ödüllendirmesini modüle eden mezokortikolimbik dopamin sisteminde örtüşen nöral devreleri göstermektedir. Sonuç olarak, MKE, bireysel yatkınlığı anlamak, risk altındaki grupları belirlemek, tedavi yaklaşımlarını kişiselleştirmek ve tedavi sonuçlarını öngörmek için güçlü bir çerçeve sunmaktadır. Kişilik

Derleme Makale (Review Article)

Geliş / Received: 05.03.2026 & **Kabul / Accepted:** 12.08.2026

DOI: <https://doi.org/10.38079/igusabder.1903782>

* Lecturer, Dr., Istanbul Gelisim University, Faculty of Health Sciences, Department of Child Development, Istanbul, Türkiye. E-mail: ueelli@gelisim.edu.tr [ORCID https://orcid.org/0009-0000-9413-7822](https://orcid.org/0009-0000-9413-7822)

değerlendirmelerinin klinik uygulamalara entegre edilmesi, madde kullanım bozukluklarının önlenmesi ve tedavisinde önemli bir değer taşıyabilir.

Anahtar Sözcükler: Mizaç ve Karakter Envanteri, MKE, madde kullanım bozuklukları, bağımlılık, kişilik, yenilik arayışı.

Introduction

Substance use disorders (SUDs) are one of the most significant global health issues of the twenty-first century, with approximately 400 million individuals affected. Together with alcohol use disorders, over 3 million deaths are related to substance use¹. SUDs are complex disorders, with high relapse rates and treatment resistance. This complexity requires a more nuanced understanding of the factors that may render certain individuals vulnerable to developing and maintaining the maladaptive patterns of substance use. Together with genetic predisposition, environmental stressors, and social factors, evidence also suggests that individual differences in personality traits constitute a significant dimension underlying susceptibility to substance abuse².

While there are various models aiming to capture the complexity of the personality as a whole, C. Robert Cloninger's psychobiological model emerges as a particularly valuable framework for understanding the multifaceted relationship between personality and substance abuse³. This model distinguishes between four heritable temperament dimensions; Novelty Seeking (NS), Harm Avoidance (HA), Reward Dependence (RD), and Persistence (PE) together with three character dimensions considered to be more sensitive to be shaped through development and learning: Self-Directedness (SD), Cooperativeness (C), and Self-Transcendence (ST)⁴. The Temperament and Character Inventory (TCI) incorporates these seven dimensions. Over the four decades since its development, TCI has been utilized in addiction research alongside other areas, consistently demonstrating that specific personality profiles are associated with increased risk for SUDs, as well as particular patterns of substance use and differential treatment outcomes⁵.

Contemporary research has expanded our understanding of personality and addiction in several ways. Recent studies suggest that personality profiles may differ between men and women and with people using different substances. In particular, women with opioid use disorder tend to display distinctly more maladaptive personality patterns than women with alcohol use disorder⁶. Contemporary neuroscience has identified distinct phenotypes such as “sign-trackers” and “goal-trackers” that reflect individual differences in susceptibility to addiction. These phenotypes also correlate with specific personality traits, particularly Novelty Seeking⁷. Advances in neuroimaging and molecular genetics reveal the neurobiological substrates underlying the relationship between personality dimensions and addiction, with specific emphasis on the role of dopaminergic, serotonergic, and other neurotransmitter systems⁸.

This review integrates recent findings with well-established findings to provide clinicians and researchers with an updated understanding of how personality assessment can enhance addiction prevention, treatment planning, and recovery. By providing an overview of behavioral, neurobiological, and clinical findings, this paper seeks to highlight the utility of the TCI as a tool for understanding the complex phenomenon of addiction in clinical practice.

Material and Methods

The present study was conducted as a narrative review. A literature search was conducted in February 2026 to identify studies examining the relationship between personality and substance use, prioritizing the studies employing TCI. A literature search was conducted to identify studies examining the relationship between personality and substance use, prioritizing the studies employing TCI. The search was performed across major academic databases such as PubMed, ScienceDirect, EBSCOhost, Taylor & Francis Online, Google Scholar, and PsycINFO. The search employed the following keywords related to the core concepts of the review: “Temperament and Character Inventory”, “TCI”, “substance use disorders”, “addiction”, “personality”, “novelty seeking”. The studies to be included have been chosen based on the following criteria: (1) The study had to be an original research article, a meta-analysis, a systematic review, or a clinical report. (2) The article had to be published in a peer-reviewed journal. (3) Articles published in English were prioritized, although relevant studies in other languages were also considered.

No specific date restrictions were applied. This allowed for an overview of the research in this field over time. Special attention was given to recent publications that highlight substance-specific and sex-specific findings, neurobiological mechanisms, and treatment implications. The information compiled from these articles provides the foundation for this review. It is structured to cover the main temperament and character dimensions and their relationship with substance abuse, followed by a discussion of the clinical and neurobiological implications. The review concludes with recommendations for future research and clinical practice.

Results

Temperament Dimensions and Substance Abuse

Novelty Seeking (NS)

Across the majority of studies in three decades of research, high Novelty Seeking emerges as one of the most robust and consistent personality trait associated with a general vulnerability to substance use across multiple substance classes^{5,9}. High NS is characterized by impulsivity, exploratory excitability, a tendency to seek out new and thrilling experiences, usually together with a reduced capacity for behavioral inhibition. This trait has been linked to an increased likelihood of initiating the use of various substances, particularly during adolescence and young adulthood¹⁰. Longitudinal studies demonstrate that high NS in early adolescence is a significant predictor of the future

development of SUDs as well as a greater number of substance classes tried and a relatively quicker transition from initial use to dependence¹¹. The motivation for novel sensations appears to make the initial rewarding effects of drugs particularly salient for these individuals with higher NS, making them at-risk for repeated use and the development of compulsive use patterns.

Recent research has also enhanced our understanding about the mechanisms underlying this relationship between Novelty Seeking and addiction vulnerability at the neurobiological level. Individuals with high NS are thought to have a constitutionally underactive mesolimbic dopamine system. This tendency may lead individuals to pursue novel experiences and substances to increase dopaminergic tone and achieve feelings of satisfaction or euphoria^{5,12}. This neurobiological underpinning helps explain why they are more prone to experiment with drugs and are more sensitive to their reinforcing effects. This mechanism may also be involved in creating a powerful drive for repeated use. In addition to human research, research on other species such as rats has revealed that sign-trackers (organisms who approach reward-predictive cues rather than the reward itself) display heightened Novelty Seeking and impulsivity¹³ and thus may be more vulnerable to developing compulsive drug use. This phenotypic distinction in other species may provide a more nuanced understanding of the underlying biological mechanisms and help explain why some individuals who experiment with drugs transition to compulsive use, while others maintain controlled use patterns.

Harm Avoidance (HA)

The relationship between Harm Avoidance and substance abuse appears to be more complex and multifaceted than originally thought. HA reflects a tendency toward worry, pessimism, shyness, fear of uncertainty, and heightened anxiety sensitivity. This definition shares conceptual similarities with the well-established personality trait of Neuroticism. While some studies find no significant difference in HA between individuals with SUDs and controls, others report higher Harm Avoidance in clinical populations, more specifically on those with dependence on depressants such as alcohol and opioids^{14,15}. This finding can be and usually interpreted within a self-medication framework, in which individuals use substances to cope with negative affective states such as anxiety, tension, dysphoria or other symptoms of internalizing disorders that are characteristic of high HA. From this perspective, substances serve a regulatory role, temporarily reducing the distress associated with high Harm Avoidance.

On the other hand, a number of research suggests that low Harm Avoidance, particularly in combination with high Novelty Seeking, is a risk factor for early-onset, antisocial, and polysubstance abuse, as these individuals may be less inhibited by the potential negative consequences of their actions and are more likely to engage in drug experimentation¹⁶. This dual pathway model (with high HA driving negative reinforcement pathways and low HA combined with high NS driving positive reinforcement and impulsive pathways) has important implications for understanding the heterogeneity of addiction presentations, as well as for tailoring treatment interventions. Research has also identified that the combination of high NS and high HA may represent a particularly

vulnerable profile. This profile would experience both a stronger drive to seek novel experiences and higher levels of anxiety that could motivate substance use as a coping mechanism¹⁷.

Reward Dependence (RD) and Persistence (PE)

Reward Dependence, defined by characteristics of a tendency to be more sentimental, to seek social approval, and to form attachments with others, seems to yield inconsistent results regarding its relationship with substance use. Some studies report low Reward Dependence in individuals with SUDs^{14,18}. This may suggest that a reduced need for social attachment and approval may facilitate a turn towards the non-social rewards offered by drugs. This detachment also could lead to social isolation and reduced social support, further reinforcing substance use patterns. However, other studies have found no significant association or even elevated RD in certain substance-using populations. The role of this trait may be highly dependent on the specific substance, cultural context, comorbid psychiatric conditions, and the stage of addiction development¹⁹.

Persistence, which refers to perseverance and the ability to continue with goal-directed behavior despite frustration or fatigue, is generally found to be lower in individuals with SUDs^{11,18}. By definition, low PE is associated with an inability to delay gratification, a tendency to give up easily when faced with obstacles as well as reduced motivation for sustained effort. These characteristics can contribute to the cycle of addiction by making it difficult for individuals to maintain abstinence when faced with cravings or environmental triggers. Individuals with low PE may struggle to maintain the motivation required for long-term recovery and may be more prone to relapse when faced with challenges, setbacks, or cravings. The combination of low PE with high NS creates a particularly vulnerable profile for compulsive substance use, as the drive for novelty is not counterbalanced by the capacity for sustained goal-directed behavior²⁰. Other studies that do not use TCI but incorporate similar constructs with different measurement devices also represent similar findings²¹.

Character Dimensions and Substance Abuse

While temperament dimensions are considered to reflect heritable predispositions established early in life, character dimensions represent the development of the self and are considered to be more malleable and responsive to therapeutic intervention. Research consistently shows that individuals with SUDs tend to exhibit character profiles that distinguish them not only from healthy controls but also from individuals with other psychiatric disorders^{14,18}.

Low Self-Directedness (SD) is the most prominent character finding in addiction research and is considered the most robust predictor of treatment outcome²². Low SD reflects a difficulty in setting and pursuing meaningful goals, a lack of personal responsibility, an external locus of control, and an inability to regulate behavior in accordance with long-term values. Individuals with low SD struggle to organize their behavior around abstract goals and are highly susceptible to the immediate gratification

provided by substances. This deficit in self-regulation is thought to be a key mechanism linking personality to the chronic, relapsing nature of addiction.

Low Cooperativeness (C) is characterized by social intolerance, a lack of empathy, opportunistic behavior, and antagonism toward others, while higher scores point to social cooperation and relatively better interpersonal relationships. Lower scores on this trait is often associated with antisocial features and can lead to interpersonal conflict, social rejection, and a lack of social support, all of which are known risk factors for the maintenance and exacerbation of SUDs. Recent findings confirm the possible relationship of lower Cooperation with SUDs¹⁸. Individuals low in cooperativeness may engage in deceptive or manipulative behaviors to obtain drugs, further damaging their social relationships and support networks. Cooperation also plays a role in engagement and sustaining of therapy, with individual scoring lower on this character trait becoming more prone to early abandonment of treatment²⁰.

The role of Self-Transcendence (ST), which involves spiritual, mystical, or transpersonal feelings and a sense of connectedness to something larger than oneself, is complex and multifaceted. While some studies have linked high ST to certain types of substance use (e.g., hallucinogens)²³, other studies report lower scores in clinical samples of SUDs compared to normal populations¹⁸. On the other hand, it has also been suggested as a possible contributing factor in recovery, particularly within the framework of 12-step programs that emphasize spiritual awakening and connection to a higher power^{24,25}.

Substance and Sex-Specific Personality Patterns in Addiction

A recent study⁶ comparing women with alcohol addiction, women with opioid addiction, and healthy controls found that women with opioid addiction displayed a distinctly more maladaptive personality profile on both Cloninger's model and the Five-Factor Model of personality compared to women with alcohol addiction and healthy controls. Specifically, opioid-addicted women scored significantly higher on Novelty Seeking and Self-Transcendence, and lower on Self-Directedness and Cooperativeness. In contrast, women with alcohol addiction more closely resembled healthy controls on most personality dimensions, suggesting that the personality pathology associated with opioid addiction is more severe and pervasive. Although it utilized a different personality model, another study from 2025 also reported sex differences in individuals with Alcohol Use Disorder, specifically in certain personality disorders such as Dependent Personality Disorder²⁶.

These findings have important implications for understanding the differential vulnerability to different types of substance use and for developing individualized prevention and treatment strategies. Women with opioid addiction for instance, appear to represent a particularly high-risk group. They tend to show more pronounced personality difficulties (showing higher impulsivity, reduced self-regulation and difficulty with interpersonal relationships) than women with alcohol addiction, suggesting that opioid use may be linked to more fundamental disruptions in personality and self-regulation. These findings also highlight the importance of taking substance-

specific factors into account when examining the relationship between addiction and personality.

Neurobiological Mechanisms Linking Personality to Addiction

Contemporary neuroscience provides insights into the neurobiological substrates that underlie the relationship between personality dimensions and addiction vulnerability. The mesocorticolimbic reward pathway, which includes the ventral tegmental area, nucleus accumbens, prefrontal cortex, and amygdala, is considered central in personality expression and the rewarding effects of drugs of abuse²⁷. This overlap in neural circuits helps explain why personality traits and addiction vulnerability may be closely intertwined. Novelty Seeking is primarily modulated by the dopaminergic system, which is involved in reward anticipation, motivation, and the attribution of incentive salience to environmental cues. Individuals with high NS are thought to have a constitutionally underactive dopaminergic system, leading them to seek stimulation and reward more actively²⁸. When exposed to drugs, which potently activate the dopamine system, high-NS individuals experience particularly strong reinforcement and are more likely to develop compulsive use patterns⁵.

Harm Avoidance is primarily associated with the serotonergic system, which is involved in behavioral inhibition, anxiety regulation, and the processing of aversive stimuli. Individuals with high HA have heightened sensitivity to threat and punishment signals and may use substances to downregulate this hyperactive threat-detection system²⁹.

Recent research has also identified distinct neural phenotypes corresponding to sign-tracker and goal-tracker behavioral patterns. Sign-trackers, who display heightened novelty seeking and impulsivity, show enhanced responsiveness of the dopaminergic system to reward-predictive cues, leading to the attribution of excessive incentive salience to drug-related cues. This cue-induced sensitization is thought to underlie the strong cravings and compulsive drug-seeking behavior seen in addiction, as these individuals are likely to be more responsive to the cues associated with drugs. In contrast, goal-trackers maintain a more flexible and adaptive relationship with reward-predictive cues, showing less cue-induced sensitization and greater behavioral flexibility⁷. Gaining insight into these neurobiological mechanisms can help guide development of pharmacological and behavioral interventions tailored to the specific neurobiological vulnerabilities lined with different personality profiles.

Conclusion and Recommendations

The literature review reveals largely consistent patterns in the personality profiles of individuals with SUDs. The findings from the literature included in this review underscore the role of temperament and character in the etiology, maintenance, and treatment of SUDs. The TCI offers a valuable perspective that moves beyond categorical diagnoses to shed light on the underlying neurobiological and psychological vulnerabilities that predispose individuals to substance use. Integrating personality assessment into clinical practice would help clinicians better identify at-risk individuals,

enable personalized and targeted interventions, as well as monitor progress and character development throughout treatment, which will bring the potential to improve outcomes for patients.

In general, a pattern of high Novelty Seeking, low Self-Directedness, and low Cooperativeness appears to be a core personality profile for an increased vulnerability to SUDs. How this profile manifests may still be subject to variation depending on gender, age, cultural context, and other individual and environmental factors.

The strong association between high Novelty Seeking and substance use highlight the role of dopaminergic functioning in addiction vulnerability. The dual pathways to addiction (one driven by the positive reinforcement of the rewarding effects of drugs in high-NS individuals and another driven by the negative reinforcement of anxiety and distress relief in high-HA individuals) provide a framework for understanding the heterogeneity of addiction presentations, which would also allow for tailoring treatment interventions to address these specific vulnerabilities of different individuals. The findings related to character dimensions, particularly low Self-Directedness, appear important for understanding the transition from substance use to addiction and for guiding therapeutic intervention.

Recent research on gender-specific personality patterns and the sign-tracker/goal-tracker phenotypes expands our understanding of individual differences in addiction vulnerability and has implications for prevention and treatment. The finding that women with opioid addiction display more dysfunctional personality traits than women with alcohol addiction suggests that different substances may be associated with distinct personality profiles. Recognizing sign-tracker and goal-tracker phenotypes provides a possible explanation to why a subset of substance users develop compulsive use patterns more easily and quickly and offers potential targets for early identification and intervention.

Although an extensive literature accumulated over three decades on the topic is available, several limitations and areas for future investigation remain. Most of the available research is cross-sectional, which makes it difficult to establish causality or to determine the direction of the reported relationships. While longitudinal studies like those by Hartman et al.¹¹ and recent prospective studies provide stronger evidence for causal relationships, more such studies are needed, particularly with longer follow-up periods and larger, more diverse samples.

Future research could also focus more on the role of character dimensions in recovery and how specific therapeutic interventions can foster character development. While temperament dimensions are relatively stable throughout adulthood, character dimensions are thought to be more malleable and responsive to therapeutic intervention. Understanding how to effectively promote character development through targeted therapeutic approaches may be a key to improving long-term recovery outcomes. Additionally, research on the integration of personality assessment with other biomarkers (e.g., genetic markers, neuroimaging findings, and stress biomarkers) may

provide a more comprehensive understanding of addiction vulnerability and may allow for more precise prediction of treatment response and relapse risk.

Clinical Implications

The insights gained from TCI research have direct and significant clinical applications that can enhance the effectiveness of addiction treatment. Personality assessment with the TCI can be used to identify at-risk individuals by screening for high-risk personality profiles (e.g., high NS, low SD, low C) in adolescents and young adults, allowing for targeted prevention efforts before the development of SUDs. Understanding a patient's unique personality profile can help clinicians tailor therapeutic strategies to address the specific vulnerabilities and strengths of each individual. For example, a patient high in NS might benefit more from engaging in novel and healthy rewarding activities, such as adventure sports, creative pursuits, or volunteer work that provides stimulation and novelty in prosocial contexts. In contrast, a patient high in HA would benefit more from support in managing anxiety and stress through cognitive-behavioral techniques, mindfulness-based interventions, and development of healthy coping strategies. Individuals who are identified to be more sensitive to cues about rewards may be the target of behavioral interventions such as Cue Exposure Therapy with Response Prevention or Contingency Management.

Certain personality profiles may be associated with a higher risk of dropout from treatment or relapse following treatment completion, and this knowledge can help clinicians provide more intensive support and monitoring to these individuals. For example, individuals with very low SD may require more structured treatment environments and more frequent therapeutic contact to maintain engagement and adherence. Individuals with lower scores in Cooperation may be targeted to modify the therapeutic frame to reduce interpersonal threat, increase therapeutic alliance, and make engagement contingencies to reduce the higher likelihood of therapy abandonment in this group. TCI can also be used to track changes in character dimensions over the course of treatment, providing a measure of psychological growth and recovery. Improvement in SD and C over time may indicate genuine personality development and psychological maturation, which are likely to be associated with better long-term outcomes. Therapeutic approaches that specifically target character development, emphasize and focus on personal responsibility, goal-setting, and interpersonal skill-building may be particularly effective for individuals with dysfunctional character traits.

REFERENCES

1. World Health Organization. *Global Status Report on Alcohol and Health and Treatment of Substance Use Disorders*. Geneva: World Health Organization; 2024.

2. Piazza PV, Deminiere JM, Le Moal M, Simon H. Factors that predict individual vulnerability to amphetamine self-administration. *Science*. 1989;245(4925):1511-1513.
3. Cloninger CR. A systematic method for clinical description and classification of personality variants. *Arch Gen Psychiatry*. 1987;44(6):573-588.
4. Cloninger CR, Svrakic DM, Przybeck TR. A psychobiological model of temperament and character. *Arch Gen Psychiatry*. 1993;50(12):975-990.
5. Wingo T, Nesil T, Choi JS, Li MD. Novelty seeking and drug addiction in humans and animals: From behavior to molecules. *J Neuroimmune Pharmacol*. 2016;11(3):456-470.
6. Rakić D, Lalović N, Barišić J, Čelić I, Milovanović S. The relationship between personality dimensions and addiction type in women addicted to alcohol and opioids. *Sci Rep*. 2025;15:2050.
7. Flagel SB, Robinson TE. Neurobiological basis of individual variation in stimulus-reward learning. *Curr Opin Behav Sci*. 2017;13:122-128.
8. Kalivas PW, Volkow ND. The neural basis of addiction: A pathology of motivation and choice. *Am J Psychiatry*. 2005;162(8):1403-1413.
9. Howard MO, Kivlahan D, Walker RD. Cloninger's tridimensional theory of personality and substance use. *J Stud Alcohol*. 1997;58(1):48-66.
10. Wills TA, Vaccaro D, McNamara G. Novelty seeking, risk taking, and related constructs as predictors of adolescent substance use: An application of Cloninger's theory. *J Subst Abuse*. 1994;6(1):1-20.
11. Hartman C, Hopfer C, Corley R, Hewitt J, Stallings M. Using Cloninger's temperament scales to predict substance-related behaviors in adolescents: A prospective longitudinal study. *Am J Addict*. 2013;22(3):276-282.
12. Volkow ND, Wise RA. How can drug addiction help us understand obesity? *Nat Neurosci*. 2005;8(5):555-560.
13. Flagel SB, Clark JJ, Robinson TE, et al. A selective role for dopamine in stimulus-reward learning. *Nature*. 2011;469(7330):53-57.
14. Evren C, Evren B, Yancar C, Erkiran M. Temperament and character model of personality profile of alcohol- and drug-dependent inpatients. *Compr Psychiatry*. 2007;48(1):283-288.
15. Akvardar Y, Arkar H, Gul S, Akdede BB. Alkol kullanım bozukluklarında kişilik özellikleri. *National Psychiatry Congress*. 2003:603-604.

16. Cloninger CR. Temperament and personality. *Curr Opin Neurobiol.* 1994;4(2):266-273.
17. Berman S, Ozkaragoz T, Young RM, Noble EP. D2 dopamine receptor gene polymorphism discriminates two kinds of novelty seeking. *Pers Individ Dif.* 2002;33(6):867-882.
18. Shahini N, Talaei A, Salimi Z, et al. Temperament and character traits in substance use disorder in Iran: A case control study. *BMC Psychol.* 2021;9(1):138.
19. Le Bon O, Basiaux P, Streel E, et al. Personality profile and drug of choice: A multivariate analysis using Cloninger's TCI on heroin addicts, alcoholics, and a random population group. *Drug Alcohol Depend.* 2004;73(2):175-182.
20. Arnau MM, Mondon S, Santacreu JJ. Using the Temperament and Character Inventory (TCI) to predict outcome after inpatient detoxification during 100 days of outpatient treatment. *Alcohol Alcohol.* 2008;43(5):583-588.
21. Zaher A, Mourad G, Ibrahim F. Relapse risk, frustration tolerance, and motivational readiness for change in substance use disorders. *BMC Psychol.* 2025;13:1329.
22. Angres DH. The Temperament and Character Inventory in addiction treatment. *Focus.* 2010;8(2):187-195.
23. MacLean KA, Johnson MW, Griffiths RR. Mystical experiences occasioned by the hallucinogen psilocybin lead to increases in the personality domain of openness. *J Psychopharmacol.* 2011;25(11):1453-1461.
24. Sørensen T, Lien L. Significance of self-transcendence for rehabilitation and relapse prevention among patients with substance use disorder: A qualitative study. *Religions.* 2022;13(6):491.
25. Hai AH, Hang A, Franklin C, Park S, DiNitto DM, Aurelio N. The efficacy of spiritual/religious interventions for substance use problems: A systematic review and meta-analysis of randomized controlled trials. *Drug Alcohol Depend.* 2019;202:134-148.
26. Morera-Fumero AL, García-Gómez MN, Jiménez-Sosa A. Clinical personality patterns in alcohol use disorder: A study focused on sex differences. *J Clin Med.* 2025;14(14):5062.
27. Koob GF, Volkow ND. Neurobiology of addiction: A neurocircuitry analysis. *Lancet Psychiatry.* 2016;3(8):760-773.

- 28.** Hansenne M, Pinto E, Pitchot W, Reggers J, Scantamburlo G, Moor M, Ansseau M. Further evidence on the relationship between dopamine and novelty seeking: A neuroendocrine study. *Pers Individ Dif.* 2002;33(6):967-977.
- 29.** Peirson AR, Heuchert JW, Thomala L, Berk M, Plein H, Cloninger CR. Relationship between serotonin and the Temperament and Character Inventory. *Psychiatry Res.* 1999;89(1):29-37.

- 1) **Istanbul Gelisim University Journal of Health Sciences** (*abbreviated title: IGUSABDER*) published three times a year, includes articles on specific research, case report and review related to Health Sciences (**Nutrition and Dietetics, Child Development, Physical Therapy and Rehabilitation, Ergotherapy, Gerontology, Nursing, Audiology, Speech and Language Therapy, Orthotics- Prosthetics, Perfusion, Healthcare Management, Social Service, Clinical, Paraclinical, Biological and Basic Sciences.**) Articles related to the field of dentistry are not included in our journal. The articles submitted to be published should be written in English. A full version of your manuscript submitted to IGUSABDER must not have been previously published.
- 2) The articles submitted for publication should be prepared in the format of
 - Times New Roman style, font size 12, A4 paper size, 1.5 line spacing and 2.5 cm margins of all edges.
 - Visual items like figures and tables should be written in the language the article is written and they should be placed appropriately in the text with the necessary explanations.
 - The titles of the tables, figures and graphics should be on the top and left aligned.
 - The abbreviations used in the article should be stated clearly where it is used for the first time and their abbreviations should be indicated between parantheses and specific abbreviations should not be used.
 - The first letters of the main titles should be capital, bold and center aligned.
 - The first letters of the sub titles should be capital, bold and left aligned.
 - Paragraph indentation should not be used.
- 3) The submission process of the article and its appendices should be carried out through DergiPark online article submission system at the address of <http://igusabder.gelisim.edu.tr> or <https://dergipark.org.tr/en/pub/igusabder>. During the submission, the authors should upload the figures of the manuscript to the online manuscript submission system. First of all, if the manuscript is accepted for publication, the copyright transfer agreement form signed by all the authors should be sent to the editorial office. **“Ethical Statement and Copyright Transfer Form”** should be signed by all authors and should be loaded to the system. Studies that requiring ethics committee approval, the **“Ethics Committee Approval Document”** should also be uploaded to the system. If the article is not accepted, the related forms will be invalid. In case the article is not accepted, related form will be invalid.
- 4) According to TUBITAK ULAKBIM DergiPark rules are required, each author should have an ORCID information and should add it to the journal profile. Authors need to enter their ORCID identity into the system while uploading their article. It is possible to obtain the ORCID number free of charge through the <https://orcid.org/signin> website.
- 5) Authors should indicate the institution, date and approval number they have received in the **Ethics Committee Approval** required for the article they wish to publish, at the end of the Discussion section of the Materials and Methods section. Statement of **“Informed Volunteer Consent/Approval Form”** to participants should be included at the end of the discussion section in statements such as conflicts of interest, thanks, supporting organizations and case reports. This information should be written in text language.

6) For all articles, Turkish and English abstracts

- Should be no more than 400 words and they should be written with at least 3 keywords.
- Only the first letter of the first key word should be capital, the other key words should be written with small letters with comas between them.
- Key words in English and Turkish should be selected in accordance with the Turkish Scientific Terms. Accessed from (<http://www.bilinterimleri.com/>).
- The necessary changes recommended for authors who do not have access to the Turkish Scientific Database are made by the Editorial Office.

7) ARTICLE TYPES

7.1. Original Research Articles: Original (full-length) Articles are original and proper scientific papers based on sufficient scientific research, observations and experiments. Articles should consist of title, abstract and keywords in Turkish and title, abstract and keywords in English as well as Introduction, Material & Methods, Results, Discussion, Conclusion and References parts. Also it should not exceed 12 pages except in exceptional circumstances (including text, tables and illustrations). There is no limit for the number of references.

The abstract should include the aim, method, results and the conclusion and it should be written accordingly with the example given below.

Example:

Abstract

Aim: The research has been made descriptively in order to determine the levels of the communication skills and the related variables.

Method: The universe of the research consists of 1116 students at the School of Health Sciences of a private university. In the research the universe has not been selected and the universe consists of 615 students that has accepted to join the research. The information form and communication skills scale has been used to collect the data. The data has been evaluated with the SPSS programme.

Results: According to the research findings, the communication skills scale score average is 156.1 ± 13.5 . When the relationship between the sociodemographic characteristics and the communication skills scale and the sub dimensions score average is analyzed, in women behavioral sub dimension score average is higher at students that have taken a theoretical education about communication ($p < 0.05$). The communication skills scale of the students' whose father's education levels are literate is higher ($p < 0.05$)

Conclusion: As a result of the research it has been determined that the communication skills score average is at medium level and it can be suggested that more lessons about communication skills should be given at all departments of the School of Health Sciences.

Keywords: Health, student, communication.

Örnek:

Öz

Amaç: Araştırma, Sağlık Bilimleri Yüksekokulu öğrencilerinin iletişim becerileri düzeylerini ve ilişkili değişkenleri belirlemek amacıyla tanımlayıcı olarak yapılmıştır.

Yöntem: Araştırmanın evrenini, İstanbul'da bulunan bir özel üniversitenin Sağlık Bilimleri Yüksekokulu'nda öğrenim gören 1116 öğrenci oluşturmuştur. Araştırmada örneklem seçimine gidilmeksizin çalışmaya katılmayı kabul eden 615 öğrenci çalışma kapsamına alınmıştır. Verilerin toplanmasında, Bilgi Formu ve İletişim Becerileri Ölçeği kullanılmıştır. Veriler SPSS programı ile değerlendirilmiştir.

Bulgular: Araştırma bulgularına göre; iletişim becerileri ölçeği puan ortalaması 156,1±13,5 bulunmuştur. Öğrencilerin sosyodemografik özellikleri ile iletişim becerileri ölçeği ve alt boyutlarının puan ortalamaları ilişkisi değerlendirildiğinde; kadınlarda, odyoloji bölümünde okuyanlarda ve iletişim ile ilgili teorik eğitim alanlarda davranışsal alt boyutu puan ortalaması daha yüksek bulunmuştur ($p<0,05$). Baba eğitim düzeyi okuryazar olan öğrencilerin iletişim becerileri ölçeği puan ortalaması daha yüksek bulunmuştur ($p<0,05$).

Sonuç: Araştırma sonucunda iletişim becerileri puan ortalaması orta düzeyde olduğu saptanmış olup, iletişim becerilerinin daha da geliştirilebilmesi için Sağlık Bilimleri Yüksekokulunun tüm bölümlerinde iletişim becerileri ile ilgili derslere daha fazla yer verilmesinin faydalı olacağı düşünülmektedir.

Anahtar Sözcükler: Sağlık, öğrenci, iletişim.

7.2. Case Report: These are the articles that describe rare significant findings encountered in the application, clinic and laboratory of related fields. The reports should include the sections of Introduction, Case History, Conclusion and References and they should not exceed 6 pages. It should be declared that the "Informed Volunteer Consent / Approval Form" was signed at the end of the discussion section.

7.3. Review: These are original articles that the author reviews a current and significant subject through the results that the author obtains from his/her own point of view and research. The reviews should include the sections of Introduction, Conclusion and Suggestions and References and they should not exceed 12 pages.

- 8) Author/Authors' e-mail addresses, institutional information, ORCID information, main text file must be included as footnotes on the first page and added to relevant places in the system during online application. In addition, in research articles -as in the example- ETHICAL STATEMENT note should be included in this part. The language of the information must be the same as the language of the article. Here is an example of how the format of this information is:

(Original Research Article)

Received: & /Accepted:

* Lecturer, Istanbul Gelisim University, Vocational School of Health Sciences, Pathology Laboratory Techniques Program, Istanbul, Türkiye. E-mail:

ORCID <https://orcid.org/.....>

** Prof. Dr., Kırıkkale University, Faculty of Arts and Sciences, Department of Biology, Kırıkkale, Türkiye. E-mail: **ORCID** <https://orcid.org/.....>

ETHICAL STATEMENT: This study was carried out with the approval of the Ethics Committee of University, dated .../.../..... and numbered A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant.

- 9) The necessary descriptive information about article (thesis, project, financial supports etc.) should be explained as footnote in article title.

- 10)** If cited in the text, it should be numbered as superscript. Also, References should be listed with numerical order as they appear in the text and the reference number should be indicated inside the parentheses at the cited text place. (For instance..... has been found¹.)

References should be written by using **Journal of American Medical Association** (JAMA Citation Style). This information can be accessed from the links below.
http://guides.med.ucf.edu/ld.php?content_id=5191991
<https://med.fsu.edu/userFiles/file/AmericanMedicalAssociationStyleJAMA.pdf>

REFERENCES

11.1. BOOKS

11.1.1. One Author	Author last name Author's first initials. <i>Title of Book</i>. Edition number. Place of publication: Publisher; year. Duyan V. <i>Sosyal Hizmet: Temelleri, Yaklaşımları, Müdahale Yöntemleri</i>. Ankara: Nar Yayınevi; 2010. Bickley LS. <i>Bate's Guide to Physical Examination and History Taking</i>. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2013.
11.1.2. More than one author (List all authors if six or less, otherwise list three followed by "et al" or "ve ark")	Author(s) last name Author(s)' first initials separated by commas. <i>Title of Book</i>. Place of publication: Publisher; year. Tayfur M, Barış O, Nazan Baştaş N. <i>Diyetisyenlik Eğitimi ve Meslek Etiği</i>. 2. baskı. Ankara: Hatiboğlu Yayınevi; 2014. Shils M, Shike M, Olson J, Ross AC. <i>Modern Nutrition in Health and Disease</i>. 9th ed. Baltimore: Lippincott Williams & Wilkins, 1998.
11.1.3. Edited book	Author(s) last name Author(s)' first initials, ed(s). <i>Title of Book</i>. Edition number. Place of publication: Publisher; year. Norman IJ, ed. <i>Mental Health Care for Elderly People</i>. New York: Churchill Livingstone; 1996.

11.1.4. Chapter or article from a book	Author(s) last name Author(s)' first initials of article. Title of article. In: Editor's name, ed(s). Title of Book. Edition number. Place of publication: Publisher; Year. Cohen M. Chronic and Acute. In: Sapphire P, ed. <i>The Disenfranchised</i>. Amityville, New York: Baywood Publishing; 2013. Phillips SJ, Whisnant JP. Hypertension and stroke. In: Laragh JH, Brenner BM, eds. <i>Hypertension: Pathophysiology, Diagnosis and Management</i>. 2nd ed. New York: Raven Press; 1995.
--	---

11.2. JOURNALS

Author(s) last name Author(s)'s first initials. Article title. Journal Title. Year;volume(issue):Inclusive page numbers.(List all authors if six or less, otherwise list three followed by "et al" or "ve ark") Sevinç S, Yavaş Çelik M. Akıba evliliklerinin çocuk sağığına etkisi ve hemşirelik yaklaşımı. <i>Sağılık ve Toplum</i>. 2016;2:23-28. Nabavi SM, Habtemariam S, Daglia M, et al. Neuroprotective effects of ginkgolide B against ischemic stroke: a review of current literature. <i>Curr Top Med Chem</i>. 2015;15(21):2222-2232
--

11.3. ELECTRONIC SOURCES

11.3.1. Electronic articles from online journals with DOI available	Author(s) last name Author(s)'s first initials. Title of article. Name of Journal. Year;volume(issue):pages. doi:11.1111. Üstün G, Aluş Tokat M. Gestasyonel diyabet emzirme sonuçları için ne kadar önemli? <i>Perinatoloji Dergisi</i>. 2011;19(3):123-129. doi: 10.2399/prn.11.0193005. Rosenbaum M, Leibel RL. Models of energy homeostasis in response to maintenance of reduced body weight. <i>Obesity</i>. 2016;24(8):1620-1629. doi: 10.1002/oby.21559.
11.3.2. Electronic articles from online journals without DOI available	Author(s). Title of article. Name of Journal. Year;vol(issue):pages. URL. Published date. Updated date. Accessed date. Thomas JL. Helpful or harmful? Potential effects of exercise on select inflammatory conditions. <i>Phys Sportsmed</i>. 2013;41(4):93-100. https://physsportsmed.org/psm.2013.11.2040. Accessed November 22, 2013.
11.3.3. (eBOOK) Book chapter/ article from eBOOK	Author(s) last name Author(s)'s first initials of chapter/article. Title of article. In: Editor's name, ed(s). Title of Book. Edition number. Place of publication: Publisher; year. URL. Accessed date: Chapter or page number or section number. Fields HL, Martin JB. Pain: pathophysiology and management. In: Longo DL, Fauci AS, Hauser SL, Kasper DL, Loscalzo J, Jameson JL, eds. <i>Harrison's Principles of Internal Medicine</i>. 18th ed. New York: McGraw-Hill; 2012. http://www.accessmedicine.com.ezproxy.med.ucf.edu/resourceTOC.aspx?resourceID=4. Accessed November 22, 2013:71-73.
11.3.4. Web pages	Author(s) or responsible body. Title of item cited. Name of website. URL. Published date. Updated date. Accessed date. World Health Organization. Philippines: Assistance and response after Typhoon Haiyan. World Health Organization. http://www.who.int/features/2013/philippinestypoonhaiyan/en/index.html. Published November 2013. Accessed November 22, 2013.

11.4. OTHER SOURCES

11.4.1. Thesis	Author last name Author's first initials. Title of Thesis. [type of thesis]. Name of the place where the thesis was made, Name of the country: Name of the department, Name of the Institute; year. Undeman C. Fully Automatic Segmentation of MRI Brain Images [master's thesis]. Stockholm, Sweden: NADA, Royal Institute of Technology;2001.
11.4.2. Conference paper	Author(s) last name Author(s)' first initials. Title of conference paper. In: Title of conference; Day month, year; Name of the place where the conference was made, Name of the country. Bengtsson S, Solheim BG. Enforcement of data protection, privacy and security in medical informatics. In: Proceedings of the 7th World Congress on Medical Informatics; Sep 6-10, 1992; Geneva, Switzerland. Abstract 209.
11.4.3. Newspaper article	Author(s) last name Author(s)' first initials. Title of newspaper article. Name of the newspaper. Day month, year. Lee G. Hospitalizations tied to ozone pollution: study estimates 50,000 admissions annually. <i>The Washington Post</i> . Jun 21, 2006:A3.

- 12) The Latin expression such as species names of bacterium, virus, parasite and fungus and anatomical terms must be written in italic character keeping their original forms.
- 13) The editorial board has the right to perform necessary revision and reduction in the article submitted for publication and to express recommendations to the authors. The articles sent to authors for correction should be sent back to the editorial office within the time specified. Articles which are pre-estimated and deemed suitable for evaluation are sent to at least two referees specialized in the related field and the article can be published after the reports and evaluations come from experts on consultative committee are evaluated and approved.
- 14) All responsibilities from published articles merely belong to the authors.
- 15) Once the article has been uploaded to the system, it is mandatory that the plagiarism checker (iThenticate, TURNITIN, URKUND) for the article be uploaded to the relevant section of the "Submit Article" module on the web page of our journal. Except for bibliography and abstract, "exclusion" should not be applied in the similarity report.
- 16) There is no copyright fee for the authors.
- 17) Published journal is sent to the authors for free.
- 18) All persons submitting articles to the journal are deemed to have accepted these rules.