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Sahibi *(Owner)*
Türkiye Fizyoterapistleri Derneği adına
(On Behalf of Turkish Physiotherapy Association)
Kenan Zafer AKSUNGUR

Yazı İşleri Müdürü
(Managing Editor)
H. Serap İNAL

TÜRKİYE FİZYOTERAPİSTLER DERNEĞİ'nin bilimsel yayın organı ve yaygın süreli yayınıdır.
(The official scientific journal of Turkish Physiotherapy Association)

"Türk Fizyoterapi ve Rehabilitasyon Dergisi"; Web of Science (WOS)-Emerging Sources Citation Index (ESCI), Cumulative Index to Nursing and Allied Health Literature (CINAHL), EBSCO, Excerpta Medica (EMBASE), Google Scholar, Türkiye Atıf Dizini ve Ulakbim Türk Tıp Dizini (TR Dizin)'nde yer almaktadır.

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"Açık Erişim Dergi" yılda 3 kez (Nisan, Ağustos, Aralık) yayınlanır.
"Open Access Journal" published 3 times (April, August, December) a year.

Yönetim Yeri Adresi *(Administration Address)*
Türkiye Fizyoterapistler Derneği Genel Merkezi
Adres: Kültür Mah. Mithatpaşa Cad. 71/13, 06420 Kızılay/ANKARA
Telefon : (0312) 433 51 71
Faks : (0312) 433 51 71
Gsm : (0507) 251 91 43
editor.turkjptr@gmail.com

Tasarım *(Design)*
Merdiven Reklam Tanıtım
Telefon: (0312) 232 30 88
www.merdivenreklam.com

Baskı *(Printing)*
Merdiven Reklam Tanıtım
Mustafa Kemal Mahallesi, 2138 Sokak, No: 6/1
Çankaya- Ankara
Tel: 0312 232 30 88

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YAZARLARIN DİKKATİNE
Genel Bilgiler

Genel Bilgiler

Türkiye Fizyoterapistler Derneği'nin resmi yayın organı olan Türk Fizyoterapi ve Rehabilitasyon Dergisi, bağımsız, tarafsız ve çift kör hakemlik ilkelerine uygun bir şekilde elektronik ve basılı olarak yayımlanan açık erişimli, ücretsiz, bilimsel bir yayın organıdır. Dergi, Nisan, Ağustos ve Aralık olmak üzere yılda 3 kez yayımlanır. Yazım dili Türkçe ve İngilizcedir. Bununla birlikte İngilizce gönderilen makalelere yayımlanma aşamasında öncelik verilecektir. Dergi, özgün araştırmalar, çağrılı derlemeler, sistematik derleme ve meta-analiz çalışmaları, ilginç olgu sunumları ve editöre mektupları yayımlamaktadır.

Derginin amacı fizyoterapi ve rehabilitasyon ile ilgili en yüksek bilimsel, etik ve klinik değere sahip orijinal çalışmaları yayımlamaktır. Türk Fizyoterapi ve Rehabilitasyon Dergisi, yayımladığı makalelerin daha önce başka bir yerde yayımlanmamış veya yayımlanmak üzere gönderilmemiş olması, ticari kaygılarda olmaması şartını gözetmektedir. Yayımlanacak makalenin tüm yazarlar tarafından ve çalışmanın yapıldığı yerdeki sorumlu kişi tarafından dolaylı olarak veya açık bir şekilde onaylandığını ve kabul edilmesi halinde aynı biçimde Türkçe, İngilizce veya başka bir dilde başka bir yerde yayımlanmayacağını taahhüt eder. Dergi, bilimsel kalitesi yüksek ve atıf potansiyeline sahip bir yazının yayına kabul edilmesi için en önemli kriter olan özgünlük ilkesini benimsemektedir.

Derginin yazım kuralları Uniform Requirements for Manuscripts Submitted to Biomedical Journals - International Committee of Medical Journal Editors (http://www.icmje.org) ve Committee on Publication Ethics (COPE) (https://publicationethics.org) tarafından yayımlanan rehberler ve politikalar dikkate alınarak hazırlanmıştır.

Türk Fizyoterapi ve Rehabilitasyon Dergisi (Türk Fizyoter Rehabil Derg / Turk J Physiother Rehabil), dünyanın her yerinden makaleler yayımlamaktadır ve aşağıdaki özelliklere sahip makalelere öncelik vermektedir:

- Fizyoterapi ve rehabilitasyon uygulamaları üzerinde etkisi olacak önemli araştırma sorularını ele alan ve hipotezleri güçlü yöntem ve araştırma tasarımı ile test eden özgün çalışmalar
- Klinik veya saha uygulamaları için temel teşkil edebilecek laboratuvar tabanlı çalışmalar
- Rehabilitasyon uygulamaları, politikaları, eğitimleri veya araştırmalarda karar vermeyi kolaylaştırmaya ve geliştirmeye yardımcı olabilecek çalışmalar.

ETİK SORUMLULUK

Editör ve Alan Editörleri

Editör ve alan editörleri, açık erişim olarak Committee on Publication Ethics (COPE) tarafından yayımlanan "COPE Code of Conduct and Best Practice Guidelines for Journal Editors" ve "COPE Best Practice Guidelines for Journal Editors" rehberleri temelinde etik görev ve sorumluluklara sahiptirler. Editörler ve alan editörleri:

- Dergide yayımlanan her makalenin dergi yayın politikaları ve uluslararası standartlara uygun olarak yayımlanmasından,
- Derginin kalitesini, özgünlüğünü ile okunurluğunu geliştirmekten,
- Fikri mülkiyet hakları ile etik standartlardan taviz vermeden şeffaf bir şekilde iş süreçlerini yürütmekten,
- Makalelerin tarafsız ve bağımsız olarak değerlendirme süreçlerinin tamamlanması için yazarlar, hakemler ve üçüncü kişiler arasında oluşabilecek çıkar ilişkisi ve çatışmalarına karşı önlem almaktan sorumludurlar.

Editörler, çalışmaların önemi, özgün değeri, geçerliliği, anlatımın açıklığı ve derginin amaç ve hedeflerine dayanarak olumlu ya da olumsuz karar verirler. Dergi yayın politikalarında yer alan "Kör Hakemlik ve Değerlendirme Süreci" politikalarını uygulamaktadırlar. Bu bağlamda editörler her çalışmanın değerlendirme sürecinin çıkar çatışması olmadan, adil, tarafsız ve zamanında tamamlanmasını sağlarlar.

Derginin editör veya editör kurulu üyelerinin yazar oldukları makalelerin değerlendirme süreçlerinin yönetilmesi için dışarıdan bağımsız bir editör davet edilebilir.

Hakemler

Türk Fizyoterapi ve Rehabilitasyon Dergisi'ne gönderilen yazılar çift kör hakem değerlendirme sürecinden geçer. Tarafsız bir değerlendirme sürecini sağlamak için her gönderi, alanlarında uzman olan en az iki bağımsız hakem tarafından incelenir. Hakemler yazıya ilişkin bilgileri gizli tutmakla yükümlüdür. Hakemler, çıkar çatışması olması halinde bu konu hakkında Türk Fizyoterapi ve Rehabilitasyon Dergisi'ne bildirimde bulunur.

Hakemler kendilerine gönderilen çalışmayı değerlendirme süreci tamamlanıncaya ve yayına verilinceye kadar herhangi bir amaç için kullanamaz. Hakemler makaleyi değerlendirirken nazik ve yapıcı bir dil kullanmalı, kötü yorum ve ifadelerden kaçınmalıdırlar. Hakemler makaleyi zamanında ve etik kurallara dikkat ederek değerlendirmekle sorumludurlar.

Yazarlar

Yazıların bilimsel içeriği ve etik kurallara uygunluğu yazar/yazarların sorumluluğundadır. Deneysel ve klinik çalışmalar ile olgu sunumlarının araştırma protokollerinin uluslararası anlaşmalara (World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects" www.wma.net) uygun olarak, etik kurul tarafından onaylanması gerekmektedir. Dergiye, etik kurul onayı almış ve Helsinki Bildirgesi'nin en güncel versiyonuna uygun yürütülmüş araştırmalar kabul edilir. Yazarlar, insan öğesi ile yapılmış çalışmalarda makalenin "YÖNTEM" bölümünde bu prensiplere uygun olarak çalışmayı yaptıklarını, kurumlarının etik kurullarından ve çalışmaya katılmış insanlardan "bilgilendirilmiş olur veya onam formlarını" (informed consent) aldıklarını belirtmek zorundadırlar. Yazarlar gerektiğinde hastalara veya katılımcılara ait bilgilendirilmiş olur veya onam formlarını belgeleyebilmelidir. Katılımcının onayı ile ilgili bilgiler, etik kurulun adı ve etik komite onay numarası da yazının "YÖNTEM" bölümünde belirtilmelidir. Etik kurul onayı gerekmeyen çalışmalar için çalışmanın tasarımı ve içeriğine uygun etik kurullardan alınan muafiyet belgesi veya sorumlu yazar tarafından yazılan bilgi amaçlı bir beyanın (meta-analiz, sistematik derleme, çağrılı derleme için) sisteme yüklenmesi gerekir. Çalışmada hayvan öğesi kullanılmış ise yazarlar, makalenin "YÖNTEM" bölümünde Guide for the Care and Use of Laboratory Animals (http://www.nap.edu/catalog/5140.html) prensipleri doğrultusunda çalışmalarında hayvan haklarını koruduklarını ve kurumlarının etik kurullarından onay aldıklarını belirtmek zorundadır.

Yazar olarak listelenen her kişi, International Committee of Medical Journal Editors (ICMJE-www.icmje.org) tarafından önerilen ve aşağıda gösterilen yazarlık kriterlerinin dördünü de karşılamalıdır:

- Çalışmanın planlanmasına, verilerin toplanmasına veya verilerin analizine ve yorumlanmasına katkısı olmalıdır,
- Makale taslağının hazırlanması veya revize edilmesine katkıda bulunmalıdır,
- Makalenin dergiye gönderilecek ve yayınlanacak son halini okuyup kabul etmelidir,
- Çalışmanın herhangi bir bölümünün doğruluğu veya bütünlüğü ile ilgili soruların uygun bir şekilde araştırıldığı ve çözümlendiği konusunda diğer yazarlarla hemfikir olmalı ve çalışmadan tüm yönleriyle sorumlu olmalıdır.

Makalelerin bilimsel içeriği ve etik kurallara uygunluğu yazarların sorumluluğundadır. Tüm çalışmalar lisanslı bir benzerlik tespit yazılımı (CrossCheck tarafından iThenticate/Turnitin vb.) tarafından taranıp ilgili rapor belge olarak başvuru sırasında sisteme yüklenmelidir. Kaynaklar, tablo ve şekil içerikleri haricindeki yazının içeriğinde benzerlik oranı %20 'nin üzerinde olmamalı ve yazarların önceki çalışmalarıyla bir benzerliği bulunmamalıdır. Benzerlik oranı %20'nin üzerindeki makaleler hakeme gönderilmeden reddedilir. İntihal, alıntı manipülasyonu ve veri sahteciliği/uydurma gibi durumlardan şüphelenilmesi veya tespit edilmesi halinde yayın kurulu COPE yönergelerini izleyecek ve bunlara göre hareket edecektir.

İletişimden sorumlu yazar makalenin sunum aşamasından basımına kadar olan süreçlerde her türlü yazışmaları gerçekleştiren yazardır. İletişimden sorumlu yazar:

- Etik kurul onay belgesi,
- Telif hakkı devir formu (e-imza veya ıslak imzalı olmalıdır. Bu formda imzası bulunanlar dışında sonradan yazar ismi eklenemez ve yazar sırası değiştirilemez.)
- Yazar katkı formu
- Çıkar çatışması formu belgelerini sisteme taratıp yüklemelidir.

Makalede, kitaplarda veya dergilerde daha önce yayımlanmış alıntı yazı, tablo, şekil vb. mevcutsa, yazarlar ilgili yazı, tablo, şekil, anket ve ölçeğin (geçerlilik, güvenirlik çalışmaları ile kullanımı için özel izin, sertifika istenen anket/ölçekler) telif hakkı sahibinden ve yazarlarından yazılı izin almak; izin yazısını makale ile birlikte göndermek ve bunu makalede belirtmek zorundadır. Hastaların kimliğini açığa çıkarabilecek fotoğraflar için hasta veya yasal temsilcisinin imzalı izinleri eklenmeli ve "YÖNTEM" bölümünde bu izinlerin alındığı ifade edilmelidir. Bilimsel toplantılarda sunulan bildiler özet şeklinde daha önce sunulmuş ve/veya basılmış ise başlık sayfasında mutlaka belirtilmelidir.

Yazım Kuralları

Makaleler, ICMJE -Recommendations for the Conduct, Reporting, Editing and Publication for Scholarly Work in Medical Journals (updated in December 2019 - http://www.icmje.org/icmje-recommendations.pdf) uyarınca hazırlanmalıdır. Yazarların CONSORT'a uygun olarak makale hazırlaması gerekmektedir. Orijinal araştırma çalışmaları için STROBE kılavuzları, sistematik incelemeler ve meta-analiz için PRISMA yönergeleri, deneysel hayvan çalışmaları için ARRIVE yönergeleri kullanılmalıdır.

Türkçe makalelerde Türk Dil Kurumu'nun Türkçe Sözlüğu esas alınmalıdır. İngilizce makaleler ve İngilizce özetlerin, dergiye gönderilmeden önce dil uzmanı tarafından değerlendirilmesi gerekmektedir. Editör veya alan editörleri gerekli gördükleri hallerde İngilizce makale veya İngilizce özet için redaksiyonun sertifikasını talep edebilirler.

Özgün Makale: Güncel ve önemli bir konuda temel veya klinik bilgi sunan, önceki çalışmaları genişletip ilerleten veya klasik bir konuda yeni bir yaklaşım getiren türde araştırmalardan oluşur. Özgün makaleler 4000 kelimeyi ve kaynak sayısı 40'ı aşmamalıdır.

Olgu Sunumu: İlginç olguları, yeni fikirleri ve teknikleri tanımlamaktadır. Şekiller, tablolar ve kaynaklar yazıyı açıklamaya ve desteklemeye yetecek en az sayıda olmalıdır. Kelime sayısı 2000'i, kaynak sayısı 20'yi geçmemelidir.

Editöryal Yorum: Editörler Kurulu, eğitim ve klinik uygulamalar konusunda uzman bir yazarı belli bir konuda bilgilendirici bir yazı yazmak veya yorum yapmak üzere davet edebilir. Kelime sayısı 1000'i, kaynak sayısı 10'u geçmemelidir.

Çağrılı Derleme/Sistematik Derleme/Meta-Analiz: Sistematik derleme ve meta-analizler doğrudan, çağrılı derlemeler ise davet edilen yazarlar tarafından hazırlanmaktadır. Fizyoterapi ve rehabilitasyon bilimi ve klinik uygulamaları hakkında olabilecek her türlü konu için güncel literatürü de içine alacak şekilde hazırlanmalıdır. Yazarların o konu ile ilgili basılmış yayınlarının olması özellikle tercih nedenidir. Kelime sayısı 6000'i, kaynak sayısı 100'ü geçmemelidir.

Editöre Mektup: Editörler Kurulunun onayı ile yayımlanmaktadır. Mektup, dergide yayımlanmış bir makaleye yorum niteliğinde ise hangi makaleye (sayı, tarih verilerek) ithaf edildiği kaynak olarak belirtilmelidir. Mektuba cevap, editör veya makalenin yazar (ları) tarafından, yine dergide yayımlanarak verilir. Mektuplarda kelime sayısı 500, kaynak sayısı beş ile sınırlıdır.

Dergide yayımlanmak üzere gönderilen makaleler;

- Yazım sayfası A4 boyutunda olacak şekilde, PC uyumlu Microsoft Word programı ile yazılmalıdır.
- "Times New Roman" yazı tipi kullanılarak 12 punto ve makalenin tüm bölümleri 1,5 satır aralıklı yapılmalıdır.
- Sayfanın her kenarında en az 2,5 cm boşluk bırakılmalıdır.
- Sayfalar (sağ alt köşede) ve satırlar numaralandırılmalıdır.
- Makalenin ana başlıkları (Giriş, Yöntem, Sonuçlar, Tartışma, Kaynaklar) büyük harf kullanılarak ve koyu olarak belirtilmelidir.
- Alt başlıklar ise baş harf büyük ve koyu renk olacak şekilde yazılmalıdır.
- Metin içinde verilen sayısal değerlerde Türkçe makalelerde virgül (,); İngilizce makalelerde nokta (.) kullanılmalıdır. Verilen bu sayısal değerlerde virgül veya noktadan sonra p ve r değerleri hariç sayının iki basamağı daha verilmeli (Örnek: 13.31 veya 15,21); p ve r değerleri ise virgülden/noktadan sonra üç basamak olacak şekilde yazılmalıdır.
- Kısaltmalar, kelimenin ilk geçtiği yerde parantez içinde verilir ve tüm metin boyunca o kısaltma kullanılır. Uluslararası kullanılan kısaltmalar için 'Bilimsel Yazım Kuralları" kaynağına başvurulabilir.

Başlık Sayfası

Makalenin başlığı kısa fakat içeriği tanımlayıcı ve amaçla uyumlu olmalıdır. Başlıkta kısaltma kullanılmamalıdır. Makale başlığı Türkçe ve İngilizce yazılmalıdır. Türkçe ve İngilizce başlıkların tamamı büyük harfler ile koyu olarak yazılmalıdır. Ayrıca yazının 40 karakterlik kısa bir başlığı da Türkçe ve İngilizce olarak başlık sayfasında belirtilmelidir. Makalenin kelime sayısı (başlık sayfası, kaynaklar, tablolar, şekiller hariç) yazılmalıdır. Tüm yazarların açık adları, soyadları (büyük harf ile yazılacak) ve akademik unvanları, çalıştıkları kurum,

iletişim bilgileri, Open Researcher and Contributor ID (ORCID) numaraları, çalışmanın yürütüldüğü kurumun veya kurumların açık adı ve adresi belirtilmelidir. Her yazar için üst numaralandırma kullanılmalıdır. İletişimden sorumlu yazarın iletişim bilgileri ayrıca sunulmalıdır. Başlık sayfası her yazarın iletişim bilgilerini, adres, güncel e-posta adresi ve iş telefon numarasını içermelidir.

Özetler

Her makale Türkçe ve İngilizce özet içermelidir.

Türkçe Özet ve Anahtar Kelimeler

Türkçe özet ayrı bir sayfadan başlamalı ve 250 kelimeden fazla olmamalıdır. Türkçe özet bölümü çalışmanın amacını, uygulanan yöntemi, en önemli bulguları ve sonucu içermelidir. Özet, "Öz" başlığını taşımalı ve "Amaç", "Yöntem", "Sonuçlar" ve "Tartışma" alt başlıklarına ayrılmalıdır. "Sonuçlar" kısmında p değeri belirtilmelidir. Türkçe makale özetlerinde ondalık sayılarda virgül (,) kullanılmalıdır.

Anahtar kelimeler 3'ten az, 5'ten çok olmamalıdır. Anahtar kelimeler "Türkiye Bilim Terimleri" listesinden (http://www.bilimterimleri.com) seçilmelidir. Bu listede henüz yer almayan yeni bir kavram için liste dışı kelimeler kullanılabilir. Anahtar kelimelerin her biri büyük harf ile başlamalı; virgül ile birbirinden ayrılmalı ve alfabetik sıraya göre yazılmalıdır. Makale Türkçe ise İngilizce özet kısmındaki anahtar kelimeler (keywords) Türkçe anahtar kelimelerin alfabetik sıralamasına uygun sıralanmalıdır.

İngilizce Özet (Abstract) ve Anahtar Kelimeler (Keywords)

İngilizce özet ayrı bir sayfadan başlamalı ve 250 kelimeden fazla olmamalıdır. İngilizce özette ondalık sayılarda nokta (.) kullanılmalıdır. İngilizce özet "Purpose", "Methods", "Results" ve "Conclusion" alt başlıklarına ayrılmalıdır. İngilizce özet ve anahtar kelimeler, Türkçe özet ve anahtar kelimelerin birebir aynısı olmalıdır. Anahtar kelimeler "MeSH (Medical Subject Headings)" terimlerinden seçilmiş olmalıdır. MeSH listesinde henüz yer almamış yeni bir kavram için liste dışı kelimeler kullanılabilir. Anahtar kelimelerin her biri büyük harf ile başlamalı; virgül ile birbirinden ayrılmalı ve alfabetik sıraya göre yazılmalıdır. Makale İngilizce ise İngilizce anahtar kelimelerin (keywords) alfabetik sıralamasına göre, Türkçe anahtar kelimeler sıralanacaktır.

Araştırma Makalesinin Bölümleri

Makale metni Türkçe makalelerde "Giriş", "Yöntem", "Sonuçlar" ve "Tartışma" bölümlerinden oluşur. İngilizce makalelerde ise "Introduction", "Methods", "Results" ve "Discussion" bölümleri yer alır. Metin içinde beş defadan fazla tekrar eden ifadeler için standart kısaltmalar kullanılabilir. Kısaltmanın açıklaması metinde ilk geçtiği yerde belirtilmelidir.

Giriş

Çalışma konusuyla ilgili önceki yayınlardan elde edilen temel bilgilerin özetini içermelidir. Çalışmanın yapılmasındaki gereklilik ve amaç kısaca belirtilmelidir.

Yöntem

Çalışmadaki klinik, teknik veya deneysel yöntemler açıkça belirtilmelidir. Yöntem için uygun kaynaklar verilmelidir. Bu bölümde yazarlar, insanlar üzerinde yapmış oldukları çalışmaları Helsinki Bildirgesi prensiplerine uygun olarak yürüttüklerini, ilgili etik kuruldan onay aldıklarını (etik kurulun adı, tarih ve protokol numarası yazılmalıdır) ve katılımcılardan bilgilendirilmiş onam alındığını belirtmek zorundadır. Yöntem bölümü "İstatistiksel analiz" alt başlığını içermelidir. Çalışmada hayvan ögesi kullanılmış ise yazarlar, Guide for the Care and Use of Laboratory Animals (http://www.nap.edu/catalog/5140.html) prensipleri doğrultusunda hayvan haklarını koruduklarını ve ilgili etik kuruldan onay aldıklarını belirtmek zorundadırlar. Katılımcıların kimliğini açığa çıkarabilecek fotoğraflar için yayın onayı alındığına yönelik bir ifade bu bölümde yer almalıdır.

İstatistiksel analiz için herhangi bir istatistik programı kullanılmış ise kullanılan yazılım programının adı, sürüm numarası, yer, tarih ve firma bilgileri yazılmalıdır. İstatistiksel analiz yöntemleri ve örneklem büyüklüğünün hesaplanması ile ilgili bilgiler gerekçeleri ile birlikte sunulmalı, gerektiğinde kaynaklarla desteklenmelidir.

Sonuçlar

Sonuçlar sayısal verilere dayanmayan herhangi bir yorum içermemelidir. Tablolarda sunulan verilerin, metin içinde tekrar edilmesinden kaçınılmalı, en önemli sonuçlar vurgulanmalıdır.

Tartışma

Tartışma, çalışmada elde edilen en önemli sonuçlara ait bilgiler ile başlamalıdır. Çalışmadan elde edilen sonuçlar yorumlanmalı ve önceki çalışmaların sonuçları ile ilişkilendirilmelidir. Tartışmada çalışmanın kısıtlılıkları, literatüre ve klinik uygulamalara olan katkısı belirtilmelidir. "Sonuçlar" bölümünde ve tablolarda yer alan bulguların, detayları ile tartışma bölümünde tekrar edilmesinden kaçınılmalıdır. Araştırmada elde edilmeyen veriler tartışılmamalıdır.

Aşağıdaki başlıklar tartışma kısmından sonra açıklamalarıyla beraber eklenmelidir:

- *Destekleyen Kuruluş:* Destekleyen kuruluşlar varsa belirtilmelidir.
- *Çıkar Çatışması:* Çıkar çatışması varsa belirtilmelidir.
- *Yazar Katkıları:* Yazarların makaleye yönelik katkıları belirtilmelidir. Katkılar fikir/kavram, tasarım, denetleme/ danışmanlık, kaynaklar ve fon sağlama, materyaller, veri toplama ve/veya işleme, analiz ve/ veya yorumlama, literatür taraması, makale yazımı, eleştirel inceleme başlıkları altında toplanmalıdır.
- *Açıklamalar:* Yazı özet ve/veya bildiri şeklinde daha önce sunulmuş ise, sunulduğu bilimsel toplantı, sunum yeri, tarihi ve basılmışsa basımı yapılan yayın organına ilişkin bilgiler "Açıklamalar" kısmında belirtilmelidir.
- *Teşekkür:* Yazar olma kriterlerini karşılamayan ancak araştırma sırasında destek sağlayan (makaleyi okuma, yazma, teknik destek, dil ve istatistik desteği vb.) bireylere ve/veya kuruluşlara ilişkin bilgiler olabildiğince kısa ve öz bir şekilde "Teşekkür" kısmında belirtilmelidir.

Kaynaklar

Kaynaklar makale ana metinden hemen sonra yer almalıdır. Kaynaklar metinde geçiş sırasına göre, cümle sonunda (noktadan önce), Arabik rakamlarla, parantez içine alınarak numaralandırılmalıdır [Örnek: ..... meydana geldiği bulunmuştur (21).]. Kaynak sayısının 40'ı aşmamasına ve 10 yıldan eski tarihli kaynak kullanımının toplam kaynak sayısının % 15'ini geçmemesine özen gösterilmelidir. Gerekmedikçe kitapların, web sayfalarının, yayınlanmamış gözlem ve kişisel görüşmelerin kaynak olarak kullanımından kaçınılmalıdır. Birden çok kaynağa atıf varsa kaynaklar arasına virgül konulmalı ve virgülden önce ya da sonra boşluk bırakılmamalıdır. Örnek olarak (3,7,15–19) verilebilir; burada "15–19", 15. kaynaktan 19. kaynağa kadar olan beş yayını kapsamaktadır. Ana metin içinde isim belirtilerek referans gösterilmesi gerektiğinde, makalenin yazım dili İngilizce ise "Yazar adı et al." (Örnek: Burtin et al.); makalenin yazım dili Türkçe ise "Yazar adı ve diğ." (Örnek: Burtin ve diğ.) şeklinde yazılmalıdır.

Dergi adları Index Medicus'a göre kısaltılmış olarak sunulmalıdır. Standart dergide yayınlanmış bir makalede, yazar sayısı 6 ve daha az ise tüm yazarların adı yazılmalıdır. Yazar sayısı 6'dan çok ise, ilk 6 yazar yazılmalı, diğer yazarlar Türkçe makaleler için "ve diğ.", İngilizce makaleler için "et al." olarak belirtilmelidir. Endnote, Mendeley gibi program kullanacak yazarlar programların içerisinde bulunan "VANCOUVER" stilini kullanmalıdır. Vancouver stilinde verilen bir referansta mutlaka olması gereken bilgiler aşağıda belirtilmiştir: - Yazar(lar) ad(ları), - Makale adı, - Dergi adı (Index Medicus'a göre kısaltılmış), - Basım yılı, - Dergi volümu ve sayısı, - Sayfa aralığı (Örnek:10-5).

Kaynak yazım örnekleri aşağıdaki gibidir:

- *Makaleler;* Burtin C, Saey D, Saglam M, Langer D, Gosselink R, Janssens W, et al. Effectiveness of exercise training in patients with COPD: the role of muscle fatigue. Eur Respir J. 2012;40(2):338-44.
- *Dergi ilavesinde yayımlanan çalışmalar;* Hielkema T, Hadders Algra M. Motor and cognitive outcome after specific early lesions of the brain–a systematic review. Dev Med Child Neurol. 2016;58(Suppl 4):46-52.
- *Kitap;* Murtagh J. John Murtagh's general practice. 4th ed. Sydney: McGraw-Hill Australia Pty Ltd; 2007.
- *Kitap b*ölümü; Cerulli G. Treatment of athletic injuries: what we have learned in 50 years. In: Doral MN, Tandogan RN, Mann G, Verdonk R, eds. Sports injuries. Prevention, diagnosis, treatment and rehabilitation. Berlin: Springer-Verlag; 2012: p. 15-9.
- *Kongre Bildirisi;* Callaghan MJ, Guney H, Bailey D, Reeves N, Kosolovska K, Maganaris K, et al. The effect of a patellar brace on patella position using weight bearing magnetic resonance imaging. 2014 World Congress of Osteoarthritis Research Society International, April 24-27, 2014, Paris. Osteoartr Cartilage; 2014;22(Suppl):S55.
- *Web sayfası;* Diabetes Australia. Gestational diabetes [Internet]. Canberra (AU): Diabetes Australia; 2015 [updated 2015; cited 2017 Nov 23]. Available from: https://www.diabetesaustralia.com.au/gestational-diabetes.

Tablolar

Tablolar, Microsoft Word dosyası formatında hazırlanmalı, her biri ayrı sayfalarda olacak şekilde makalenin sonunda yer almalı ve ana metinde geçtikleri sıraya göre numaralandırılmalıdır. Toplam tablo ve şekil sayısı en fazla 6 olmalıdır. Tablolarda her sütun başlığına kısa bir başlık yazılmalıdır. Tabloların sütunlarında her kelimenin ilk harfi büyük olmalıdır. Tablo numara ve başlığı tablonun üst kısmında yer almalı; tablo numarası koyu renk ile yazılmalı, tablo başlığından nokta (.) ile ayrılmalıdır (Örnek: **Tablo 1.** Katılımcıların Sosyodemografik Özellikleri). Tablolarda dikey çizgi kullanılmamalı sadece ilk satır üstünde, altında ve son satırın altında yatay çizgiler olmalıdır. Tabloda yer alan p değerleri *, ** ile gösterilmelidir. Notlar ve tabloda kullanılan kısaltmaların açıklamaları tablonun alt kısmında yazılmalıdır. Kısaltmaların açıklamasının yazımında önce kısaltma yazılmalı, iki nokta üst üste (:) işaretinden sonra kısaltmanın açık hali yazılmalıdır. Kısaltmalar birbirinden virgül ile ayrılmalıdır. Tabloda kullanılan değişkenlerin birimleri parantez içinde belirtilmelidir. Belirli bir aralığı kapsayan birimler aralık dilimi ile sayısal olarak ifade edilmelidir. Tabloda verilen ondalık sayılarda, Türkçe makalelerde virgül (,); İngilizce makalelerde nokta (.) kullanılmalıdır. Tablolarda verilen ondalık sayılarda virgül veya noktadan sonra iki basamak yazılmalıdır (Örnek: 31,12 veya 20.10). Ortalama, yüzde ve ortanca değerleri dışındaki değerler (p, r, vb.) virgülden/noktadan sonra üç basamak olarak yazılmalıdır. Tablo örneği aşağıda bulunmaktadır.

Tablo 1. Grupların Bilgi Testi Sonuçları

Bilgi Testi	TU Grubu (n=20)	SH Grubu (n=20)	TU-SH Grubu (n=20)	t	p§
Ön Test	60,50±13,17	69,05±14,11	67,14±14,54	0,002	0,051
Son Test	83,00±14,18	73,50±9,33	83,33±10,17	0,002	**0,001**

*p<0,05. §Kruskal Wallis Analizi. TU: Teorik/uygulamalı ders grubu, SH: Simüle hasta grubu, TU-SH: Teorik/uygulamalı ders ve simüle hasta grubu.

Şekiller

Şekil başlıkları tablolardan sonra ayrı bir sayfada yer almalıdır. Şekiller ise ayrı bir dosya olarak JPEG, TIFF, PNG formatında yüksek kalitede yüklenmelidir. Makale içinde kullanılan fotoğraflar net olmalıdır. Fotoğraf ve şekiller metin içinde geçiş sırasına göre numaralandırılmalıdır. Yazarlar, insan öğesinin bulunduğu fotoğraflarda, kişiden yazılı izin ve kimliğini gizleyecek önlemler almalıdırlar. İzin metni makale ile birlikte dergiye gönderilmelidir. "YÖNTEM" bölümünün ilk paragrafında yayın onayı alındığına dair bilgi verilmelidir.

Makale Gönderme Formatı

Makaleler Microsoft Office Word dosyası formatında hem yazar isimleri olan hem de yazar isimleri içermeyen iki kopya şeklide DergiPark (http://dergipark.gov.tr/tjpr) sistemine kullanıcı olarak kayıt olunduktan sonra yüklenecektir. Yazar isimlerinin bulunmadığı Word dosyasında adı geçen tüm kurumların (etik kurul onayın alındığı kurum da dahil olmak üzere) "X" ile kapatılması gerekmektedir.

Makale Değerlendirme Süreci: Derginin yayın süreci, Uluslararası Tıbbi Dergi Editörleri Komitesi (ICMJE), Dünya Tıbbi Dergi Editörleri Birliği (WAME), Bilim Editörleri Konseyi (CSE), Yayın Etiği Komitesi (COPE), Avrupa Bilim Editörleri Birliği (EASE) ve Ulusal Bilgi Standartları Organizasyonu (NISO) kılavuzları ile uyumludur. Yazar makalenin değerlendirme sürecini DergiPark (http://dergipark.gov.tr/tjpr) sisteminden takip edebilmektedir. Dergiye gönderilen yazılar ilk olarak, teknik editör tarafından yazının dergi yönergelerine uygunluğu açısından değerlendirilecektir. Derginin yönergelerine uymayan yazılar, teknik düzeltme talepleriyle birlikte yazara tekrar gönderilecektir. Makaleler ilgili alanda uzman en az iki dış hakem tarafından değerlendirmeye tabi tutulacak ve hakem raporları, iletişimden sorumlu yazara bildirilecektir. Revizyon gerektiren makalelerde yazarın hakem yorumlarını birebir yanıtlaması ve makalenin revize edilmiş versiyonunu yüklemesi gerekir. Bu süreç, yayın kurulu makaleye onay verene kadar tekrarlanır.

Telif Hakkı

Sorumluluk Reddi

Türk Fizyoterapi ve Rehabilitasyon Dergisi'nde yayımlanan yazılardaki ifadeler veya görüşler, editörlerin, yayın kurulunun veya yayıncının görüşlerini değil yazarların görüşlerini yansıtmaktadır. Editörler, yayın kurulu ve yayıncı bu tür materyaller için herhangi bir sorumluluk veya yükümlülük kabul etmemektedir. Yayınlanan içerikle ilgili nihai sorumluluk yazarlara aittir.

Instructions for Authors

Turkish Journal of Physiotherapy and Rehabilitation is the official journal of the Turkish Physiotherapy Association. Turkish Journal of Physiotherapy and Rehabilitation is open-access, free, impartial, and employs a double-blind peer-review process published electronically and in print. It is published three times a year, in April, August, and December, in Turkish and English. The manuscripts submitted in English will be given priority in the publication process. We are pleased to receive articles reporting original scientific research, invited reviews, systematic reviews or meta-analyses, rare case studies, and letters to the editor.

The journal aims to publish original studies of the highest scientific, ethical, and clinical value on physiotherapy and rehabilitation. Submission of an article implies that the work described has not been published previously, that it is not under consideration for publication elsewhere, that it is not having commercial concerns. The publication of an article is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in Turkish, English or any other language. The journal adopts the principle of originality, which is the most important criterion for an article with high scientific quality and citation potential to be accepted for publication.

The editorial rules of the journal are based on the guidelines published by Uniform Requirements for Manuscripts Submitted to Biomedical Journals - International Committee of Medical Journal Editors (http://www.icmje.org) and Committee on Publication Ethics (COPE) (https://publicationethics.org).

Turkish Journal of Physiotherapy and Rehabilitation (Turk J Physiother Rehabil) publishes articles from all over the world and gives priority to articles with the following characteristics:

- Original studies that address important research questions that will have an impact on physiotherapy and rehabilitation practices and test hypotheses with a strong method and research design
- Laboratory-based studies that can be the basis for clinical or field applications
- Studies that can help facilitate and improve decision-making in rehabilitation practices, policies, education, or research.

ETHICAL RESPONSIBILITY

Editorial Board

Editors have ethical duties and responsibilities based on the "COPE Code of Conduct and Best Practice Guidelines for Journal Editors" and "COPE Best Practice Guidelines for Journal Editors" published by the Committee on Publication Ethics (COPE) as open access. **Editors:**

- Every article published in the journal is published by journal publication policies and international standards,
- To improve the quality, originality, and readability of the journal,
- To conduct processes transparently without compromising intellectual property rights and ethical standards,
- To complete the impartial and independent evaluation processes of the articles, they are responsible for taking precautions against conflicts of interest that may arise between the authors, reviewers, and third parties.

Editors make positive or negative decisions based on the importance, original value, and validity, clarity of the narrative, and the journal's goals and objectives. They apply the "Blind Peer-Review and Evaluation Process" policies included in the publication policies of the journal. In this context, the editors ensure that the evaluation process of each study is completed in a fair, impartial, and timely manner without conflict of interest.

An independent external editor may be invited to manage the evaluation processes of the articles in which the editorial board members are the authors.

Reviewers

Manuscripts submitted to the Turkish Journal of Physiotherapy and Rehabilitation go through a double-blind peer-review process. To ensure an unbiased review process, each submission is reviewed by at least two independent reviewers who are experts in their fields. The reviewers are obliged to keep the information about the article confidential. In case of a conflict of interest, the reviewers notify the Turkish Journal of Physiotherapy and Rehabilitation.

The reviewers cannot use the article sent to them for any purpose until the evaluation process is completed and it is published. Reviewers should use kind and constructive language while evaluating the article and avoid bad comments and expressions. The reviewers are responsible for evaluating the article on time and by paying attention to the ethical rules.

Authors

The scientific content of the manuscripts and their compliance with ethical principles are under the responsibility of the author(s). The ethics committee must approve research protocols of experimental and clinical studies and case reports following international agreements (World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects" www.wma.net). The journal accepts manuscripts which; have been approved by the relevant Ethical Committees and are by ethical principles stated in the Declaration of Helsinki. The authors must state that they conducted the study according to the abovementioned principles in the "METHOD" section for studies conducted on human subjects. They also must express ethical committee approval and obtain "informed consent forms" from volunteers who participated in the study. Authors should document informed consent or consent forms of patients or participants when necessary. Information about the approval of the volunteers, the name of the ethics committee, and the ethics committee approval number should also be stated in the "METHOD" section of the manuscript. For studies that do not require ethics committee approval, letter of an exemption from the ethics committee in accordance with the design and content of the study or an informative statement written by the responsible author (for meta-analysis, systematic review, or invited review) should be uploaded to the system. In studies involving "animals," the author(s) should state in the "Methods" section that they have protected the rights of the animals by the principles of "Guide for the Care and Use of Laboratory Animals" (http://www.nap.edu/catalog/5140.html) and obtained approval from the relevant Ethical Committees.

Each person listed as an author must meet the following 4 criteria for authorship recommended by the International Committee of Medical Journal Editors (ICMJE-www.icmje.org:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

The scientific content of the articles and their compliance with ethical principles are the responsibility of the authors. All studies must be checked by a licensed plagiarism detection software (iThenticate/Turnitin etc., by CrossCheck) and uploaded to the system as a supplementary document at the time of application.

The similarity rate in the content of the article should not be over 20% and should not have any similarity with the previous works of the authors except for the references, table, and figure contents. Articles with a more than 20% similarity rate are rejected without being sent to the referee. In case of suspected or detected plagiarism, citation manipulation, and data forgery/fabrication, the editorial board will follow the COPE guidelines and act accordingly.

The corresponding author carries out all kinds of correspondence from the presentation stage to the printing of the article. The corresponding author should scan and upload the following documents to the system.

- Ethics committee approval form,
- Copyright transfer form (must be e-signed or original signed. Another author's name cannot be added later, and the order of authors cannot be changed, except for those whose signatures are on this form.)
- Author contribution form
- Conflict of interest form
- Publication rights agreement form

Suppose there are cited articles, tables, and figures previously published in articles, books, or journals. In that case, the authors must obtain written permission from the copyright holder for the table, figure, survey, and scale (validity, reliability studies and special permission for its use, certificate/scales), send the permission letter together with the article, and indicate this in the article. In addition, the signed permission of the patient or his legal representative should be attached for the photographs that may reveal the identity of the patient, and it should be stated in the "METHOD" section. Finally, if the papers are presented in scientific meetings and presented and/or published in the abstracts book, authors must be stated on the title page.

Instructions for Authors

Articles should be prepared following ICMJE -Recommendations for the Conduct, Reporting, Editing, and Publication for Scholarly Work in Medical Journals (updated in December 2019 - http://www.icmje.org/icmje recommendations.pdf). In addition, authors are required to prepare an article in accordance with the Consolidated Standards of Reporting Trials (CONSORT) Statement. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement should be used for original research studies, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement should be used for systematic reviews and meta-analysis, and Animal Research: Reporting of In Vivo Experiments (ARRIVE) Statement for experimental animal studies.

Turkish dictionary of Turkish Language Institution should be considered in Turkish manuscripts. A native speaker should edit the manuscripts and abstracts in English before being submitted to the journal. Editors or field editors may request proofreading for English articles or English abstracts if they deem necessary.

Original Article: It consists of research that provides basic or clinical information on a current and essential topic, extends, and advances previous studies, or introduces a new approach to a classic topic. Original articles should not exceed 4000 words, and the number of references should not exceed 40.

Case Report: It describes interesting cases, novel ideas, and techniques. Figures, tables, and references should be as minimal as possible to explain and support the text. The number of words should not exceed 2000, and the number of references should not exceed 20.

Editorial Comment: The Editorial Board may invite an author who is an expert in education and clinical practice to write an informative article or comment on a particular subject. The number of words should not exceed 1000, and the number of references should not exceed 10.

Invited Review/Systematic Review/Meta-Analysis: Systematic reviews and meta-analyses are prepared directly, while invited authors prepare invited reviews. They should also include the current literature for any subject about physiotherapy and rehabilitation science and clinical applications. It is especially preferred that the authors have published publications on that subject. The number of words should not exceed 6000, and the number of references should not exceed 100.

Editorial Letter: It is published with the approval of the Editorial Board. If the letter is a commentary on an article published in the journal, it should be stated as the source to which article (number, date) it is dedicated. The answer to the letter is given by the editor or the author(s) of the article, again by publishing it in the journal. The number of words in the letters is limited to 500, and the number of references is limited to five.

Articles submitted for publication in the journal;

- The writing page should be A4 size, with a PC-compatible Microsoft Word program.
- "Times New Roman" font with a 12-font size should be used, and all parts of the article should be written with 1.5 line spacing.
- At least 2.5 cm of space should be left on each side of the page.
- Pages (bottom right corner) and lines should be numbered.
- The main headings of the article (Introduction, Method, Results, Discussion, and References) should be written in capital letters and in bold.
- Sub-headings should begin with a capital letter as a sentence case and bold.
- In the numerical values given in the text, a comma (,) should be used in Turkish articles and a period (.) in English articles. In these numerical values given, two more digits of the number should be given after the comma or period, excluding p and r values (Example: 13.31 or 15.21); the p and r values should be written as three digits after the comma/period.
- Abbreviations are given in parentheses at the first occurrence of the word, and that abbreviation is used throughout the text. Reference can be made to the scientific spelling rules for internationally used abbreviations.

Title Page

The title of the manuscript should be brief but descriptive for the content and compatible with the purpose. Article title should be written in Turkish and English. The Turkish and English titles should be written in bold with capital letters. Besides, a short running title (not exceeding 40 characters) should be specified both in Turkish and English on the title page. The number of words (excluding title page, references, tables, and figures) of the article should be written. Full names, surnames (written in a capital letter), academic titles, institutions, and digital identifiers Open Researcher and Contributor ID (ORCID) of the authors, full name and address of the clinic, department, institute, hospital, or university which the study was conducted at should be declared using superscript numbers for each author. The contact information of the corresponding author should also be specified. The title page should include each author's contact information, address, current e-mail address, and business phone number.

Abstracts

Each manuscript should include both Turkish and English abstracts.

Turkish Abstract and Keywords

The Turkish abstract should begin from a separate page and not exceed 250 words. The Turkish summary section should include the purpose of the study, the methods, the primary findings, and the result. The abstract should be titled "Öz" and divided into subheadings of "Purpose," "Methods," "Results," and "Conclusion." The p-value must be specified in the "Results" section. A comma (,) should be used in decimal numbers in Turkish article summaries.

The number of keywords should not be less than 3 or more than 5. Keywords should be selected from the "Turkey Science Terms" list (http://www.bilimterimleri.com). The out-of-list terms may be used for a new concept. Each keyword begins with an uppercase letter, separated by a comma and written in alphabetical order. If the article is in Turkish, the keywords in the English abstract should be written in the alphabetical order of the Turkish keywords.

English Abstract and Keywords:

The English abstract should begin on a separate page and not exceed 250 words. A period (.) should be used in decimal numbers in the English summary. English abstract must be divided into subheadings of "Purpose," "Methods," "Results," and "Conclusion." The English abstract and keywords should be the same as the Turkish abstract and keywords. Keywords should be selected from "MeSH (Medical Subject Headings)" terms. The out-of-list terms may be used for a new concept that has not taken place in MeSH yet. Each keyword begins with an uppercase letter, separated by a comma and written in alphabetical order. If the article is in English, the keywords in the Turkish abstract should be sorted according to the alphabetical order of the English keywords.

Sections of the Original Research Articles

The sections of Turkish Article consist of "Giriş", "Yöntem", "Sonuçlar" and "Tartışma". In English articles, there are "Introduction," "Methods," "Results," and "Discussion" sections. Abbreviations can be used for the expressions repeated more than five times in the manuscript. The explanation of the abbreviation should be stated in the first place in the text.

Introduction

The introduction should summarize the basic knowledge obtained from previous studies related to the study topic. The rationale and purpose of the study should be described briefly.

Methods

The clinical, technical, or experimental methods in the study should be clearly stated. Appropriate references should be given for the method. In this section, the authors must state that they carried out their studies on humans in accordance with the principles of the Declaration of Helsinki, that they received approval from the relevant ethics committee (name of the ethics committee, date, and protocol number should be written) and informed consent was obtained. The method section should include the subtitle as "Statistical analysis." If an animal is used in the study, the authors should state that they protect animal rights in line with the principles of the Guide for the Care and Use of Laboratory Animals (http://www.nap.edu/catalog/5140.html) and have obtained approval from the relevant ethics committee. A statement that publication approval has been obtained for photographs that may reveal the identity of the participants should be included in this section.

If any statistical program is used, the name of the software program, version number, location, date and company information should be written. Information on statistical analysis methods and the calculation of sample size should be presented and supported with references when necessary.

Results

The results should not contain any interpretation that is not based on numerical data. In the text, repetition of the data presented in the tables should be avoided, and the most important results should be emphasized.

Discussion

The discussion should begin with information on the most important results obtained in the study. Results from the study should be interpreted and correlated with the results of previous studies. In the discussion, the limitations of the study, its contribution to the literature, and clinical practice should be stated. It should be avoided to repeat the findings in the "Results" section and the tables with their details in the discussion section. Data not obtained in the study should not be discussed.

The following titles should be added after the discussion section with their explanations:

- *Sources of Support:* If there are supporting organizations, it should be specified.
- *Conflict of Interest:* It should be stated if there is a conflict of interest.
- *Author Contributions:* Authors' contributions to the article should be stated. Contributions should be gathered under the headings of idea/concept, design, supervision/consulting, resources and funding, materials, data collection and/or processing, analysis and/or interpretation, literature review, article writing, critical review.
- *Explanations:* If the article has been presented in the form of an abstract and/or a conference proceeding before, information about the scientific meeting, place, and date of the presentation, and if published, the publication organ should be stated in the "Explanations" section.
- *Acknowledgement:* Information about individuals and/or organizations that do not meet the criteria for being an author but provided support during the research (reading the article, writing, technical support, language, and statistical support, etc.) should be stated in the "Acknowledgements" section as briefly and concisely as possible.

References

References should be placed after the main text. References should be numbered in the order of occurrence in the text, at the end of the sentence (before the point), with Arabic numerals, and in parentheses [Example: ..... it was found (21).]. The number of references should not exceed 40, and the use of references older than ten years should not exceed 15% of the total number of references. Unless necessary, the use of books, web pages, unpublished observations, and personal interviews as references should be avoided. If more than one reference is cited, a comma should be placed between them, and no spaces should be left before or after the comma. An example (3,7,15–19) can be given; "15–19" covers five publications from reference 15 to reference 19. If the article is in English, the references that the name will indicate in the text should be specified as "Author's name et al." (Example: Burtin et al.); if the text is in Turkish, the references that the name will indicate in the text should be specified as "Yazar adı ve diğ." (Example: Burtin ve diğ.).

Journal names should be presented in abbreviated form as in Index Medicus. All authors should be written if the number of authors is six or less in the standard journal. If the number of authors is more than 6, the first six authors should be written, and the other authors should be specified as "ve diğ." for Turkish articles and "et al." for English articles. Authors who will use programs such as Endnote, Mendeley should use the "VANCOUVER" style. The information that must be included in a reference given in Vancouver style is as follows:

- Author(s) name(s), - Article title, - Journal name (abbreviated as in Index Medicus), - Publication year, - Journal volume and issue, - Page range (Example:10-5).

Reference writing examples are as follows:

- *Article;* Burtin C, Saey D, Saglam M, Langer D, Gosselink R, Janssens W, et al. Effectiveness of exercise training in patients with COPD: the role of muscle fatigue. Eur Respir J. 2012;40(2):338-44.
- *Studies published as a supplement of the journal;* Hielkema T, Hadders Algra M. Motor and cognitive outcome after specific early lesions of the brain–a systematic review. Dev Med Child Neurol. 2016;58(Suppl 4):46-52.
- *Book;* Murtagh J. John Murtagh's general practice. 4th ed. Sydney: McGraw-Hill Australia Pty Ltd; 2007.
- *Book Section;* Cerulli G. Treatment of athletic injuries: what we have learned in 50 years. In: Doral MN, Tandogan RN, Mann G, Verdonk R, eds. Sports injuries. Prevention, diagnosis, treatment and rehabilitation. Berlin: Springer-Verlag; 2012: p. 15-9.
- *Congress Papers;* Callaghan MJ, Guney H, Bailey D, Reeves N, Kosolovska K, Maganaris K, et al. The effect of a patellar brace on patella position using weight bearing magnetic resonance imaging. 2014 World Congress of Osteoarthritis Research Society International, April 24-27, 2014, Paris. Osteoartr Cartilage; 2014;22(Suppl):S55.
- *Web page;* Diabetes Australia. Gestational diabetes [Internet]. Canberra (AU): Diabetes Australia; 2015 [updated 2015; cited 2017 Nov 23]. Available from: https://www.diabetesaustralia.com.au/gestational-diabetes.

Tables

Tables should be prepared in Microsoft Word file format, placed at the end of the article on separate pages, and numbered according to the order in which they occur in the main text. The total number of tables and figures should be at most 6. A short title should be written for each column heading in the tables. The first letter of each word in table columns must be capital. Table number and title should be at the top of the table; "table" should be written in bold, separated from the table title by (.) (Example: **Table 1.** Sociodemographic Characteristics of the Participants). Vertical lines should not be used in tables, and only horizontal lines should be used above and below the first line and below the last line of the table. The p values in the table should be indicated with *, **. Notes and explanations of abbreviations used in the table should be written at the bottom of the table. While writing the explanation of the abbreviations, the abbreviation should be written first, and the open version of the abbreviation should be written after the colon (:) sign. Abbreviations should be separated by commas. The units of the variables used in the table should be specified in parentheses. Units covering a certain range should be expressed numerically by the range segment. In decimal numbers given in tables, comma (,) in Turkish articles; point (.) in English articles should be used. In the decimal numbers given in the tables, two digits should be written after the comma or the point (Example: 31,12 or 20.10). Values other than a mean, percent, and median values (p, r, etc.) should be written as three digits after the comma/point (Please see the example table below).

Table 1. Knowledge Test Results of the Groups

Knowledge Test	Group TP (n=20)	Group SP (n=20)	Group TP-SP (n=20)	t	p§
Pre Test	60.50±13.17	69.05±14.11	67.14±14.54	0.002	0.051
Post Test	83.00±14.18	73.50±9.33	83.33±10.17	0.002	**0.001**

*p<0,05. §Kruskal Wallis Analysis. TP: Theoretical/practical course group, SP: Simulated patient group, TP-SP: Theoretical/practical course, and simulated patient group.

Figures

A list of figures should be placed on a page after the list of tables. The authors are expected to submit good quality figure(s) in JPEG, TIFF, or PNG versions as separate files. The photographs used in the manuscript should be clear. The photographs and figures should be numbered in the order in which they are referenced. If the manuscript involves humans, written consent of the participants should be collected, and precautions should be taken to disguise individuals' identities. The text of the consent form should be sent to the journal with the manuscript. It should be indicated in the first paragraph of the "METHOD" section that the written consent was collected from the participants.

Manuscript Submission

Two copies of the manuscript should be prepared for submission as Word files. One file must have all author details included, and the other must be anonymized. Both versions should include the title, abstract, body, and references. All institutions mentioned in the anonymous file (including the institution where the ethics committee approval was obtained) must be written as "X." Both copies will be uploaded (after registering as a user) in the DergiPark (http://dergipark.gov.tr/tjpr) system.

Peer Review Process: The editorial and publication process of the journal is shaped following the guidelines of the International Committee of Medical Journal Editors (ICMJE), World Association of Medical Journal Editors (WAME), Council of Science Editors (CSE), Committee on Publication Ethics (COPE), European Association of Science Editors (EASE), and National Information Standards Organization (NISO). The author(s) will be able to follow the evaluation process of the article from the DergiPark system (http://dergipark.gov.tr/tjpr). Manuscripts submitted to the journal will first go through a technical evaluation process where the editorial office staff will ensure that the manuscript has been prepared and submitted following the journal's guidelines. Submissions that do not conform to the journal's guidelines will be returned to the submitting author with technical correction requests. The articles will be evaluated by at least two external referees who are experts in the relevant field, and the referee reports will be sent to the corresponding author. If a revision is required, the author should respond to all referee comments and upload the revised version of the manuscript. This process will be repeated until the editorial board approves the manuscript.

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EDİTÖRDEN

Değerli Okurlarımız,

Türk Fizyoterapi ve Rehabilitasyon Dergisi'nin 2025 yılı Nisan sayısı ile dört yıllık görev süremizin sonuna geldiğimizi ve bu değerli görevi yeni Baş Editörümüz Prof. Dr. Baran YOSMAOĞLU ve Editörlerine devretmekten ziyadesiyle mutluluk duyduğumuzu bildirmek isterim. Fizyoterapi ve Rehabilitasyon alanında güncel ve etkili çalışmaları okuyucularımızla buluşturmaya ve Dergimizi daha da ileri seviyelere taşımaya devam edeceklerine olan inancım tamdır.

Bu süreçte, yazar, hakem ve okuyucu olarak bizlerle birlikte olan ve çalışmalarımızı destekleyen tüm akademisyen ve klinisyenlere teşekkürlerimizi sunuyoruz.

Bu sayıda sizlere sunduğumuz on araştırma ve bir bibliyometrik analiz çalışmasının Alan Editörleri olan Prof. Dr. Sevgi Sevi Yeşilyaprak, Prof. Dr. Seher Özyürek, Prof. Dr. Zeynep Hoşbay, Dr. Özge Çankaya, Doç. Dr. Rüstem Mustafaoğlu, Prof. Dr. İlkim Çıtak Karakaya, Doç. Dr. Sevtap Günay Uçurum, Doç. Dr. Dilber Karagözoğlu Coşkunsu, Doç. Dr. Yasin Yurt, Doç. Dr. Nuray Alaca'ya; Yazım Editörlerimiz olan Dr. Merve Kurt Aydın, Dr. Şule Okur Dündar, Dr. Nurel Ertürk, Dr. Atahan Turhan, Dr. Çiçek Günday, Doç. Dr. Ceyhun Türkmen, Dr. Yunus Emre Tütüneken, Dr. Uğur Verep, Dr. Kübra Kardeş, Dr. Cengiz Taşkaya, Uzm. Fzt. Nurhayat Korkmaz, Dr. Elif Develi'ye; İstatistik Editörümüz Doç. Dr. Öznur Büyükturan'a; Yayın Editörlerimiz Dr. Tansu Birinci Olgun ve Dr. Pınar Baştürk Merç'e ve tüm Editörlerimize huzurlarınızda teşekkürlerimi sunmak isterim.

Sizlere, Olimpiyatların sloganı olan "Citius, Altius ve Fortius - Daha Hızlı, Daha Yüksek, Daha Güçlü" sözcükleri ile veda etmek isteriz. Geçirdiğimiz bu dört yıllık dönemde Türkiye Fizyoterapistler Deneğinin yayın organı olan Türk Fizyoterapi ve Rehabilitasyon Dergisi'ni devralmış olduğumuz önceki Editörümüz Prof. Dr. Deniz İnal İnce ve ekip arkadaşları Editörlerimiz gibi daha yükseğe taşımaktan, daha güçlü hale getirmekten mutluyuz. Ulaşmış olduğumuz bu noktaya gelirken, daha hızlı olmak yerine yine sağduyu, tarafsızlık ve etik değerler ile yol almayı benimseyen, Dergimizin kalitesini ve etki gücünü arttırmak için özveriyle ve ekip ruhu içinde çalışan tüm Editörlerimize ve hakemlerimize şükranlarımı sunarım.

Saygılarımla,

Prof. Dr. H Serap İNAL

EDİTÖRDEN

Sevgili Meslektaşlarım, Değerli Araştırmacılar ve Okuyucular,

Ülkemizde fizyoterapi ve rehabilitasyon biliminin gelişimine önemli katkılarda bulunan Türk Fizyoterapi ve Rehabilitasyon dergisinin editörlük görevini devralmanın heyecanını ve onurunu yaşıyorum. Benden önce bu görevi büyük bir özveriyle yürüten değerli hocamız Prof. Dr. Serap İnal başta olmak üzere tüm önceki editörlere teşekkür ederek sözlerime başlamak isterim. Onların liderliğinde dergimiz, ulusal ve uluslararası düzeyde saygınlık kazanmış, kaliteli bilimsel yayınlarıyla alana yön vermiştir. Bu güçlü mirası devralmak, hem büyük bir sorumluluk hem de mesleğin gelişimi açısından önemli bir fırsattır.

Fizyoterapi ve rehabilitasyon, yaşam kalitesini artırmaya yönelik bilimsel ve klinik temelleri olan dinamik ve oldukça geniş bir sağlık disiplinidir. Günümüzde teknolojik gelişmeler, multidisipliner yaklaşımlar ve bireyselleştirilmiş sağlık hizmetleri ile birlikte mesleğimizin araştırma alanı da hızla genişlemektedir. Bu çerçevede dergimizin misyonunu, yalnızca bilimsel bilgi üretmekle sınırlı görmüyor; aynı zamanda bu bilginin erişilebilir, uygulanabilir ve yenilikçi olması gerektiğine inanıyorum. Yeni dönemde hedefimiz; hem nitelikli araştırmaları destekleyen hem de genç araştırmacılara yol gösterici olan bir yayın politikası izlemektir. Açık bilim anlayışı, hakemlik süreçlerinde şeffaflık, etik ilkelere bağlılık ve uluslararası iş birliklerini teşvik eden bir vizyonla çalışmalarımızı sürdüreceğiz. Ayrıca, klinik uygulamalarla bilimsel çalışmaları daha sıkı biçimde buluşturan içeriklere de yer vererek, akademi ile sahayı birbirine daha da yaklaştırmayı amaçlıyoruz.

Bu süreçte, editörler kurulumuzun, hakemlerimizin, yazarlarımızın ve siz değerli okuyucularımızın desteği en büyük gücümüz olacaktır. Hep birlikte, dergimizi fizyoterapi alanındaki yeniliklerin ve gelişmelerin öncüsü haline getireceğimize yürekten inanıyorum.

Bu yeni yolculukta bana duyulan güven için Türkiye Fizyoterpistler Derneği Yönetim Kurulu'na teşekkür ediyor, birlikte üretken, etik ve ilham verici bir yayın süreci geçirmeyi temenni ediyorum.

Yayın Kurulu adına,

Saygılarımla,

Yayın Kurulu adına,

Saygılarımla,

Prof. Dr. Hayri Baran YOSMAOĞLU

Baş Editör

EDİTÖRDEN

Dear Readers,

I would like to announce that with our April 2025 issue, we have come to the end of our four-year term at the Turkish Journal of Physiotherapy and Rehabilitation, and we are happy to hand over this valuable duty to our new Editor-in-Chief Prof. Dr. Baran YOSMAOĞLU and his Editors. I have full confidence that they will continue to bring together current and effective studies in the field of physiotherapy and rehabilitation with our readers and thus carry our Journal to higher levels.

We would like to thank all academics and clinicians who have been with us throughout this process and supported our work as authors, referees and readers.

I would like to express my gratitude to our Section Editors Prof. Sevgi Sevi Yeşilyaprak, Prof. Seher Özyürek, Prof. Zeynep Hoşbay, Dr. Özge Çankaya, Assoc. Prof. Rüstem Mustafaoğlu, Prof. İlkim Çıtak Karakaya, Assoc. Prof. Sevtap Günay Uçurum, Assoc. Prof. Dilber Karagözoğlu Coşkunsu, Assoc. Prof. Yasin Yurt, and Assoc. Prof. Nuray Alaca; Technical Editors Dr. Merve Kurt Aydın, Dr. Şule Okur Dündar, Dr. Nurel Ertürk, Dr. Atahan Turhan, Dr. Çiçek Günday, Assoc. Prof. Ceyhun Türkmen, Dr. Yunus Emre Tütüneken, Dr. Uğur Verep, Dr. Kübra Kardeş, Dr. Cengiz Taşkaya, MSc. PT. Nurhayat Korkmaz, Dr. Elif Develi; Statistics Editor Assoc. Prof. Öznur Büyükturan; Publishing Editors Dr. Tansu Birinci Olgun and Dr. Pınar Baştürk Merç and all our Editors, for the ten research studies and one bibliometric analysis study that we present to you in this issue.

We would like to bid you farewell with the words of the Olympic motto: "Citius, Altius and Fortius – Faster, Higher, Stronger". We are happy to carry the Turkish Journal of Physiotherapy and Rehabilitation, the official publication of the Turkish Physiotherapists Association, to a higher level and make it stronger, just like our previous Editor Prof. Dr. Deniz İnal İnce and her teammates, whom we took over four-years ago.

I would like to express my gratitude to all our Editors and referees who have adopted the principle of proceeding with common sense, impartiality and ethical values instead of speeding up, and who have worked devotedly and in team spirit to increase the quality and impact of our Journal.

Kind Regards,

H. Serap İNAL, PT. Prof.

EDİTÖRDEN

Dear Colleagues, Researchers and Readers,

I am excited and honored to take over the editorship of the Turkish Journal of Physiotherapy and Rehabilitation, which has made significant contributions to the development of science of physiotherapy and rehabilitation in our country. I would like to start my words by thanking all previous editors, especially our esteemed professor Prof. Dr. Serap İnal, who carried out this duty with great dedication. Under their leadership, our journal has gained respect at national and international levels and has led the field with its quality scientific publications. Taking over this strong legacy is both a great responsibility and an important opportunity for the development of the profession.

Physiotherapy and rehabilitation is a dynamic and quite broad health discipline with scientific and clinical foundations aimed at improving the quality of life. Today, with technological developments, multidisciplinary approaches and individualized health services, the research area of our profession is also rapidly expanding. In this context, we do not see the mission of our journal as limited to producing scientific knowledge alone; I also believe that this knowledge should be accessible, applicable and innovative. Our goal in the new period; to follow a publication policy that both supports qualified research and guides young researchers. We will continue our work with a vision that encourages open science, transparency in refereeing processes, commitment to ethical principles and international collaborations. In addition, we aim to bring the academy and the field closer together by including content that brings clinical applications and scientific studies together more closely.

In this process, the support of our editorial board, reviewers, authors and you, our valued readers, will be our greatest strength. I sincerely believe that together, we will make our journal a pioneer of innovations and developments in the field of physiotherapy.

I would like to thank the executive board of the Turkish Physiotherapists Association for the trust placed in me in this new journey and wish that we will have a productive, ethical and inspiring publication process together.

On Behalf of the Editorial Board,

Kind Regards,

Hayri Baran YOSMAOĞLU, PT. Prof.

Editor-in-Chief

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Türk Fizyoterapi ve Rehabilitasyon Dergisi

ARAŞTIRMA MAKALELERİ (ORIGINAL ARTICLES)

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Tuğba DERE, PT, MSc[1,2]
Selen SEREL ARSLAN, PT, Prof[1]
İpek ALEMDAROĞLU-GÜRBÜZ, PT, Prof[1]

1 Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Ankara, Türkiye
2 Yozgat Bozok University, Sarikaya School of Physiotherapy and Rehabilitation, Yozgat, Türkiye

Correspondence (İletişim):

Tuğba DERE
School of Sarıkaya Physical Therapy and Rehabilitation, Yozgat Bozok University, Yozgat, Turkey, E-mail: tugba.dere@yobu.edu.tr , ORCID: 0000-0002-3048-9113

Selen SEREL ARSLAN
E-Mail: selen.serel@hacettepe.edu.tr
ORCID: 0000-0002-2463-7503

İpek ALEMDAROĞLU-GÜRBÜZ
E-mail: ipekalemdaroglu@windowslive.com
ORCID: 0000-0001-5556-6608

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THE ASSOCIATION BETWEEN ABILITY TO SUSTAIN PHYSICAL ACTIVITY AND QUALITY OF LIFE OF PRESCHOOL CHILDREN WITH CEREBRAL PALSY, AND PSYCHOSOCIAL STATUS OF CAREGIVERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study aimed to present the relationship between the ability to maintain physical activity in preschool children with cerebral palsy (CP) and quality of life, and the psychosocial status of caregivers.

Methods: Fifty-five children with CP and their caregivers were included in the study. The ability to maintain physical activity and quality of life were determined by the Early Activity Scale for Endurance (EASE) and Pediatric Outcomes Data Collection Instrument (PODCI), respectively. The psychosocial status of caregivers was assessed by Impact on Family Scale (IFS), Beck Depression Inventory (BDI) and State Trait Anxiety Inventory (STAI).

Results: The mean age of children (28 Female, 27 Male) and their caregivers (45 Female, 10 Male) was 46.96±14.66 months and 33.81±7.65 years, respectively. Significant correlations were found between EASE and PODCI sub-parameters ($p<0.05$). However, there were no significant correlations between EASE and the IFS, BDI and STAI ($p>0.05$). Statistically significant correlations were detected between PODCI-happiness and IFS ($p=0.042$, $r=-0.293$) and PODCI-transfer/mobility and BDI ($p=0.044$, $r=-0.273$).

Conclusion: This study suggests that the ability to sustain physical activity of preschool children with CP is closely related to their quality of life and the psychological well-being of caregivers is affected from the severity of impact of the disease on caregivers. The quality of life of preschool children with CP can be improved by holistic approaches aiming to improve the endurance for physical activity and psychological well-being of their caregivers.

Keywords: Anxiety; Caregivers; Cerebral palsy; Depression; Physical activity

OKUL ÖNCESİ SEREBRAL PALSİLİ ÇOCUKLARIN FİZİKSEL AKTİVİTEYİ SÜRDÜREBİLME YETENEĞİ VE YAŞAM KALİTESİ İLE, BAKIM VERENLERİN PSİKOSOSYAL DURUMU ARASINDAKİ İLİŞKİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı okul öncesi serebral palsili (SP) çocuklarda fiziksel aktiviteyi sürdürebilme yeteneği ile yaşam kalitesi ve bakım verenlerin psikososyal durumları arasındaki ilişkiyi araştırmaktır.

Yöntem: Çalışmaya 55 SP'li çocuk ve bakım verenleri dahil edildi. Fiziksel aktiviteyi sürdürme yeteneği ve yaşam kalitesi sırasıyla Endurans için Erken Aktivite Skalası (EEAS) ve Pediatrik Veri Toplama Aracı (PVTA) ile belirlendi. Bakım verenin psikososyal durumu Aile Etki Ölçeği (AEÖ), Beck Depresyon Ölçeği (BDÖ) ve Durumluk-Sürekli Kaygı Envanteri (DSKE) ile değerlendirildi.

Sonuçlar: Çocukların (28 Kadın, 27 Erkek) ve bakım verenlerin (45 Kadın, 10 Erkek) yaş ortalaması sırasıyla 46,96±14,66 ay ve 33,81±7,65 yıl idi. EEAS ile PVTA alt parametreleri arasında anlamlı ilişkiler bulundu ($p<0,05$). Ancak, EEAS ile AEÖ, BDÖ ve DSKE arasında anlamlı ilişkiler bulunmadı ($p>0,05$). PVTA-mutluluk ile AEÖ ($p=0,042$, $r=-0,293$) ve PVTA-transfer/mobilite ile BDÖ ($p=0,044$, $r=-0,273$) arasında istatistiksel olarak anlamlı ilişkiler tespit edildi.

Tartışma: Bu çalışma, okul öncesi SP'li çocukların fiziksel aktiviteyi sürdürebilme yeteneğinin yaşam kalitesi ile yakından ilişkili olduğunu ve bakım verenlerin psikolojik iyilik hallerinin, hastalığın bakım veren üzerindeki etkisinin şiddetinden etkilendiğini düşündürmektedir. Okul öncesi SP'li çocukların yaşam kalitesi, endurans için fiziksel aktivite düzeyini ve bakım verenin psikolojik iyilik halini iyileştirmeyi amaçlayan bütünsel yaklaşımlarla geliştirilebilir.

Anahtar Kelimeler: Anksiyete; Bakım verenler; Serebral palsi; Depresyon; Fiziksel aktivite

INTRODUCTION

Cerebral palsy (CP) is a non-progressive neurodevelopmental condition characterized by abnormal muscle tone, impaired movement and postural development caused by damage to the immature brain. Sensory, cognitive communication and behavioral problems may also accompany these disorders. CP is known to be the most common group of childhood physical disorders with an incidence of 1.5 to 4 per 1000 births worldwide (1). Physical activity is defined as any physical movement that is generated by skeletal muscles and results in energy expenditure in daily life (2). Children with CP participate less in physical activity than their typically developing peers, and they have a greater period of inactivity during the day (3). Internal factors including postural disorders, pain, muscle tone changes, fatigue, nutritional problems (2) and external factors such as lack of parental support and environmental restrictions (3) can cause low physical activity levels and more sedentary time in these individuals. Increased sedentary time may result in social isolation and depression in children with CP (4). It is also emphasized that it is crucial to monitor the presence of problems related to the level of physical activity considering the recent evidence regarding the increasing prevalence of secondary problems such as stroke and heart problems in these individuals (5).

The ability to sustain physical activity in children with CP is an important parameter that affects an individual's social participation (6). This has led to a growing interest in development and implementation of interventions aimed at increasing the predisposition to be physically active for children with CP in recent years (6,7). Thus, it is necessary to determine the physical activity levels in this group. However, considering the age criteria of the limited number of current measurement methods regarding physical activity (8,9), such methods are not suitable for determining the level of physical activity of preschool children with CP. Therefore, it is thought that determining the capacity of children with CP aged 2 to 5 years to sustain physical activity may help predict their physical activity levels during school-age years and adolescence (6), allowing for early interventions and guidance (10).

CP causes many musculoskeletal problems and affects the daily life of children and their families (11). Previous studies have reported that caregivers of children with CP are significantly affected physically and psychologically (1, 11) and that parents often experience problems such as psychological anxiety, financial problems, and restriction in social and cultural activities. This brings along a burden of care that affects all caregivers (11). Families of children with CP cope with many circumstances such as diagnostic process and its acceptance, provision of adequate care and fulfilling expectations. While some families can adapt to this process and go through successfully, some families have difficulty coping with these problems and experience high levels of depression (12). A meta-analysis study reports that depressive disorders were more common in mothers of children with CP than in mothers of healthy children (13). In addition, the burden of caring for mothers of children with CP exceeds the time requirements of the typical family and leads to additional pressure due to their efforts to meet the continuous care requirements (11, 14). Therefore, it is argued that mothers of children with CP who have lower functional level experience more stress and have lower quality of life. As a result, it has been reported that programs targeting children with CP and their caregivers have started to gain importance in recent years to maintain long-term mental and physical health in children with CP and their caregivers (14).

Caregiver stress and psychological distress may affect the quality of care provided and limit the child's participation in rehabilitation and social activities. Therefore, coping with caregiver stress is crucial not only for the well-being of the caregiver, but also for the healthy development of the child. Even though many studies have been conducted on the psychosocial state of the families of the individuals with disability, that the lack of studies which investigate the impact of the physical activity of the individuals with disability on caregiver and psychosocial state of caregivers have been reported (15). The objective of this study is to contribute to the development of holistic approaches by addressing a gap in the existing literature and elucidating the factors associated with the ability to sustain physi-

cal activity in preschool children with CP and the effects of these factors on their caregivers. Karatekin et al. also suggested that the behavioral aspects of the children with CP affect caregivers physically and psychologically, and children and their families should be evaluated together in future studies (16). The purpose of the study was to investigate the relationship between the ability to sustain physical activity in preschool children with CP and quality of life, and the psychosocial status of their caregivers.

METHOD

This cross-sectional study was conducted in collaboration with Hacettepe University Faculty of Physical Therapy and Rehabilitation and Yozgat Bozok University Sarikaya School of Physiotherapy and Rehabilitation. The study protocol was approved by the Non-Interventional Clinical Research Ethics Committee of Yozgat Bozok University under the decision no. 2017-KAEK-189_2022.07.28_01. The study was carried out between August 2022 and December 2022, based on the Declaration of Helsinki. Written consents were obtained from the caregivers who participated in the study.

Participants

This study was conducted with children aged between 2 to 5 years who were diagnosed with CP by a pediatric neurologist, and their literate caregivers. Children who underwent orthopedic surgery or diagnosed with a metabolic disease or a neuromuscular or severe respiratory disease in addition to CP, or whose caregivers had communication problems were excluded from the study.

The sample size of the present study was determined based on the assessment results of the study conducted by Bjornson et al. (17). Statistical power values for each statistical significance test were obtained using the G*POWER program. The effect size was calculated as 0.616, and it was found that a minimum of 32 children should be included for a power of 80.6% and a significance level of 5%. The study was completed with the inclusion of 55 children with CP and their caregivers.

Assessments

Descriptive Information and Functional Status Assessment

Age (month), height (cm), weight (kg), body mass index (kg/m2), gender and CP type of children; and age (year), education levels and professions of the caregivers were recorded in the study.

Functional levels of the children were identified by the Gross Motor Function Classification System (GMFCS). Revised in 2007 and shown to be valid for children with CP in Turkish by El et al., the GMFCS evaluates the ability to perform the defined daily functions at a certain level in 5 levels between Level 1 to Level 5, of which Level 1 indicates the highest, and Level 5 shows the lowest functional level (19).

Assessment of the Ability to Maintain Physical Activity

The ability to sustain physical activity in children with CP was assessed by the Turkish version of the Early Activity Scale for Endurance (T-EASE) which was recently found as valid and reliable in the Turkish preschool children with CP.

The original instrument was developed by McCoy et al. in 2012, and it has been shown to be valid and reliable in determining the endurance for physical activity of preschool children with CP aged between 2 to 5 years (19). The T-EASE consists of 10 questions and takes approximately 10 minutes to complete, and each item is scored between 1 to 5. For items 1, 2, 3, 4, 5, 7, 8 and 9, the caregiver chooses the option that is most suitable for the child among “always, usually, sometimes, rarely, never”, depending on the activity asked. Items 6 and 10 include selection of the most accurate duration depending on the maximum time the child spends in the specified directive. A score of 1 to 5 is given depending on the selected duration. After item 6, caregivers are asked whether their children are mobilized independently, and if the response is “no”, the questionnaire is terminated where the entire instrument is answered if the answer is “yes”. Therefore, while the minimum score that an individual without independent mobility can get is 6, the minimum score that an individual with independent mobility can get is 10. The highest possible score is 50. A higher total score means that the endurance required to be physically active is higher, while higher scores in items 4 and 9 indicate more fatigue (10,19).

Assessment of Quality of Life of Children

The functional health condition and health-related quality of life of children with CP were assessed with the child form of the Pediatric Outcomes Data Collection Instrument (PODCI) (20,21), which has been demonstrated to be a valid and reliable tool for use with Turkish children with CP aged 2 to 10 years. The instrument includes 86 questions under the subscales as global function, upper extremity function, transfers and basic mobility, sports and physical function, pain and comfort and happiness sub-parameters. According to each subscale score and the global score, which is calculated by summing each subscales' scores, 0 point indicates worser health condition while 100 points indicate maximum level of health quality (20).

Assessment of Psychosocial Characteristics of the Caregivers

The impact of child's disease on caregivers was assessed by the Impact on Family Scale (IFS) which was adapted to Turkish and tested for reliability and validity by Beydemir et al. in 2009 (22,23). The IFS includes four basic categories including financial burden, familial and social affection, personal difficulty and coping with 27 items in total. Three items of the IFS are not included in the scoring system. Each remaining item is scored between 1 to 4, and a minimum score of 24 and maximum score of 96 can be obtained from the questionnaire. The higher the overall score the more the parents are affected by the disease of their child (22,23).

Caregivers' depression levels were assessed by the Beck Depression Inventory (BDI). The BDI is a scale developed by Beck et al. to assess the severity of depression, which contains the symptoms frequently shown by depressed individuals, and it was found to be valid and reliable in Turkish. It includes 21 items in total, and each item is scored between 0 to 3. BDI takes approximately 5 to 10 minutes to complete. The score between 10 and 16 points indicates mild depression symptoms, 17 to 29 points indicates moderate depression symptoms, and 30 to 63 points indicates serious depression symptoms (24,25).

The Turkish version of the State-Trait Anxiety Inventory (STAI) was used to assess the anxiety levels of the caregivers. It is a two-part scale with 20 items in each part. State anxiety is an indicator of the emotions and individual feels due to stressful situations. Trait anxiety indicates anxiety that is persistent and does not occur according to a specific situation or time. The total score ranges between 20 to 80, and a higher score indicates higher levels of anxiety (26,27).

Statistical Analysis

Statistical software package SPPS 25 (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) was used to assess the data. Descriptive statistics (mean-X, standard deviation-SD, minimum value-min, maximum value-max, number-n and percentile-%) were given for categorical and continuous variables in the study. The homogeneity of the variances, one of the preconditions of parametric tests, was checked by the "Levene" test. The assumption of normality was checked by the "Shapiro-Wilk" test. Since it was found that the data did not conform to the normal distribution, it was decided that non-parametric conditions were fulfilled. The relationships between continuous variables were analyzed by the Spearman Correlation Coefficient (r). A relationship strength of $r>0.90$ was defined as very strong, 0.70 to 0.90 as strong, 0.40 to 0.70 as moderate, 0.20 to 0.40 as weak, and <0.20 as very weak or insignificant correlation (28). Statistical significance level (p) was accepted as 0.05.

RESULTS

A total of 55 preschool children with CP and their caregivers were included in the study. The descriptive and physical information related to the children and their caregivers was shown in Table 1. The CP types of the children were as follows: 22% (n=12) hemiparetic CP, 31% (n=17) diparetic CP, 31% (n=17) quadriparetic CP, 11% (n=6) hypotonic CP, and 5% (n=3) ataxic CP. It was found that 23 (58%) of the individuals with CP used different orthoses such as ankle foot orthoses or knee-ankle foot orthoses while 22 individuals (42%) did not use any orthoses.

According to the GMFCS levels, 11% of children (n=6) were in level I, 38% (n=21) were in level II, 20% (n=11) were in level III, 15% (n=8) were in level IV, and 16% (n=9) were in level V. Table 2 shows the

Table 1. Descriptive Characteristics of Children with CP and Their Caregivers (n=55).

Children with Cerebral Palsy	**Minimum**	**Maximum**	**X ± SD**
Age (months)	24	60	46.96±14.66
Height (cm)	75	120	93.87±12.21
Weight (kg)	8	25	14.57±4.3
Body Mass Index (kg/m2)	10.7	29.6	16.46±3.42
		n	**%**
Gender	Female	28	51
	Male	27	49
Caregivers of Children with Cerebral Palsy	**Minimum**	**Maximum**	**X ± SD**
Age (years)	22	56	33.81±7.65
		n	**%**
Gender	Female	45	82
	Male	10	18

X: Mean, SD: Standard Deviation.

results of T-EASE and PODCI scores of the children and the IFS, BDI, and STAI results of the caregivers.

The relationships between the T-EASE and PODCI scores of children with CP and the psychosocial status of their caregivers were given in Table 3. Significant weak-to-strong correlations were found between the T-EASE scores and the PODCI-upper extremity (r=0.639, p=0.001), PODCI-transfer and basic mobility (r=0.827, p=0.001), PODCI-sport and physical function (r=0.809, p=0.001), PODCI-happiness (r=0.320, p=0.017), PODCI-global (r=0.787, p=0.001) scores of children.

Statistically significant correlations were detected between PODCI-happiness and IFS (r=-0.293, p=0.042) and PODCI-transfer/mobility and BDI (r=-0.273, p=0.044). However, there were no significant correlations between the T-EASE scores and the caregivers' IFS (r=0.152, p=0.268), BDI (r=-0.182, p=0.184) and state anxiety (r=0.091, p=0.511), trait anxiety (r=-0.114, p=0.407) scores.

DISCUSSION

In this study which was performed to determine the relationship between the ability to sustain physical activity in preschool children with CP and their

Table 2. The Results of the Outcome Measures (n=55)

Outcomes Measures (Minimum-Maximum)	**Subscales of the Scale (Minimum-Maximum)**	**X±SD**	**Minimum-Maximum**
Children with Cerebral Palsy			
Early Activity Scale for Endurance (6-50)		26.58±13.65	6-49
Pediatric Outcomes Data Collection Instrument	Upper Extremity (0-100)	29.89±14.03	0-53
	Transfers and Basic Mobility (0-100)	31.07±22.89	0-91
	Sports and Physical Function (0-100)	25.87±12.11	1-49
	Pain and Comfort (0-100)	38.38±17.93	1-55
	Happiness (0-100)	32.22±18.67	0-57
	Global (0-100)	30.49±16.52	0-59
Caregivers			
Impact on Family Scale (24-96)		52.02±12.25	34-88
Beck Depression Inventory (0-63)		12.44±9.34	0-36
State-Trait Anxiety Inventory	State Anxiety (20-80)	35.78±14.59	20-73
	Trait Anxiety (20-80)	42.69±9.11	29-63

X: Mean, SD: Standard Deviation.

Tablo 3. The Associations Between the Outcome Measures (n=55).

Outcomes Measures		Early Activity Scale for Endurance (EASE)	Pediatric Outcomes Data Collection Instrument					
			Upper Extremity Function	Transfers and Basic Mobility	Sports and Physical Function	Happiness	Pain and Comfort	Global
Early Activity for Endurance Scale	r	-	0.639	0.827	0.809	0.320	0.180	0.787
	p	-	**0.001***	**0.001***	**0.001***	**0.017***	0.189	**0.001***
Impact on Family Scale	r	0.152	0.045	0.105	0.009	-0.293	0.254	0.136
	p	0.268	0.744	0.447	0.950	**0.042***	0.062	0.323
Beck Depression Inventory	r	-0.182	-0.256	-0.273	-0.200	-0.012	-0.094	-0.245
	p	0.184	0.059	**0.044***	0.143	0.933	0.495	0.071
State Anxiety	r	0.091	-0.163	-0.057	0.016	0.035	-0.039	-0.086
	p	0.511	0.234	0.678	0.906	0.800	0.775	0.533
Trait Anxiety	r	-0.114	-0.110	-0.199	-0.197	-0.030	-0.243	-0.214
	p	0.407	0.422	0.145	0.149	0.828	0.074	0.117

*: p<0.05, r: Spearman Correlation Coefficient

quality of life, and psychosocial state of the caregivers, it was found that the endurance levels required to sustain physical activity of children with CP is closely related to their quality of life. Even though no direct relationship was found between the ability to maintain physical activity in preschool children with CP and the psychosocial status of their caregivers, the "happiness" of children was determined to be associated to the impact of child's disease on caregivers. In addition, the depression level of caregivers was related to the transfer and mobility skills of their children.

Quality of life is defined as physical and psychosocial well-being, and it is emphasized in previous studies that children with CP have a lower level of quality of life than their healthy peers (3, 26). In the literature, it was found that personal and environmental factors are related to the quality of life of children with CP (29). In terms of functionality, it was reported that GMFCS levels of preschool children with CP were related to their quality of life (30). Furthermore, ambulant children with CP demonstrated significantly enhanced parent-reported quality of life, functioning, participation, and physical health status in comparison to children without ambulation (29). In addition, it has been observed that the quality of life of children with CP varies according to the type of CP, with children with quadriparetic CP having a lower quality of life than children with other types of CP (2,29). The fact that 51% of the study population were between GMFCS Levels 3-5 without independent mobility and 62% consisted of diparetic and quadriparetic children in the current study, it was not surprising that the quality of life of overall study population remained below average. Among the other factors related to the quality of life of children with CP, previous literature also suggested that secondary problems such as musculoskeletal pain, the use of assistive devices, the lack of financial support and/or moral support from people around the children might also be associated with quality of life of children with CP (31). Physical activity is also known to be important in improving the quality of life of children with CP. Regular participation in physical activity is known to lead to improvements in musculoskeletal strength, cardiovascular fitness or endurance, quality of life, spasticity, and overall physical function including functional mobility and walking performance (29). Abanoz et al, in a study of individuals with CP, reported that determining the physical activity levels of ambulatory children with CP and directing them to individual programs of physical activity will enable them to participate more actively in life and pave the way for them to

be active in older age (32). Besides these factors, this study revealed another factor, endurance to maintain physical activity, as a contributor to the quality of life of preschool children with CP. Therefore, considering the quality-of-life results of the current study, it reveals the importance of early detection of the ability to sustain physical activity in preschool children with CP to predict his/her quality of life, and suggests that timely intervention to increase the capacity for physical activity may lead to better health-related quality of life in many aspects in children with CP.

Caregivers of children with CP included in this study showed below-average family impact and anxiety levels with mild depression symptoms. Park et al. showed that the depression observed in caregivers negatively affected their caring skills and participation in social activity. It was stated that caregiving-related conditions such as depression, anxiety, and stress varied depending on the age of the disabled individual (33). Similarly, according to Beck et al., although depression was reported as a complex condition caused by the perception of a significant loss or the threat of such a loss (34), stressors played more important role in the course of depression than anxiety (35). Thus, it was stated that the depression and anxiety levels of the caregivers of disabled individuals might change depending on the age of the disabled person. It was also reported that mothers might experience higher levels of anxiety during the diagnosis where depressive symptoms might appear over time (35). The young adult caregivers in this study exhibited lower levels of anxiety with mild depressive symptoms, which aligns with the recent literature that suggests the age of the disabled individual is a contributing factor to depressive symptoms in caregivers.

The stress of caregivers who take care of an individual with a chronic condition is the primary risk factor for developing psychosocial problems in both the affected child and caregivers. These stressors may be caused by the severity of the disease and the functional limitations associated with the disease (36). According to a systematic review, the prevalence of depression and anxiety in the parents of children with CP is higher than the parents of typically developing children and with other diseases (37). In addition, a review of the relevant literature revealed that the mothers of CP children with lower motor functional level had higher levels of depression and anxiety (34). Ahmadizadeh et al. found that mothers of the children with CP have mild depression, and this maternal depression had a significant correlation with the daily activities of the individual with CP rather than the severity of CP (38). In this study, there was a relationship between the depression level of caregivers and the transfer/basic mobility sub-test of PODCI. According to this result of current study, it is thought that the decreased functionality of the children with CP due to the decreased mobility ability may affect the social participation of caregivers which, in turn, affect the depression level of the caregiver. On the other hand, according to some of the findings of the literature, depression or anxiety levels of mothers with CP were not related to the level of functionality or disability of children with CP (39,40). This is attributed to the failure of parents to meet their social needs due to the physical impact of an individual with CP. One of the main challenges observed in general with the parents of disabled individuals involves managing their children's chronic health problems effectively and fulfilling this role along with the requirements of daily life. Therefore, providing the necessary support for parents with disabilities may have an impact on their social and psychological well-being (36). The mental health of caregivers is of pivotal importance in this context. A greater caregiving burden is consistently associated with increased levels of depressive symptoms, a diminished quality of life for caregivers, and more pronounced physical disabilities in their children. Irrespective of the functional abilities of the child, caregivers frequently encounter a wide range of challenges, including restricted access to external assistance, financial limitations, and inadequate resources for both the caregiver and the child (39, 40). Prolonged social isolation and feelings of helplessness among caregivers can contribute to elevated stress levels, which in turn exacerbate the psychological burden (40). In the current study, the relationship between the family impact and the happiness sub-test of PODCI suggests that as the disease impact on caregivers increases, they may experience difficulty in providing the necessary psychosocial support to their children with CP, which can affect the emotional status of their children.

Limitations

The small sample size of the study, and therefore the inability to analyze subgroups by GMFCS level, is considered a limitation of the study.

CONCLUSION

This study indicated better quality of life of preschool children with CP if they performed better to sustain physical activity. The current study also indicated that the impact of the disease on caregivers' depression levels was related to the child's psychological well-being and mobility skills, respectively. The reduced ability to sustain physical activity in preschool children with CP, whose transfer and mobility skills decline with age, may lead to an increase in caregiver impact. Therefore, holistic approaches to improving the quality of life of children with CP should also aim to reduce the impact of the disease on caregivers by focusing on children's mobility skills and ability to sustain physical activity.

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Aylin TANMAN, PT, MSc.[1,2]
Arzu ERDEN GÜNER, PT, Assoc. Prof[3]
Ali Faruk ÖZYAŞAR MD, Asst. Prof[4]
Murat TOPBAŞ MD, Prof. Dr[5]

1 *Institute of Health Science, Department of Elderly Health, Muğla Sıtkı Koçman University, Muğla, Turkiye,*
2 *Institute of Health Science, Division of Anatomy, Karadeniz Technical University, Trabzon, Turkey*
3 *Faculty of Health Science, Division of Physiotherapy and Rehabilitation, Karadeniz Technical University, Trabzon, Turkey*
4 *Faculty of Medicine, Division of Anatomy, Karadeniz Technical University, Trabzon, Turkey*
5 *Faculty of Medicine, Division of Public Health, Karadeniz Technical University, Trabzon, Turkey*

Correspondence (İletişim):

Aylin TANMAN, PT, MSc
Muğla Sıtkı Koçman University, Department of Elderly Health, Muğla, Turkiye, E-mail: aylintanmann@gmail.com, ORCID: 0000-0002-6043-421X

Arzu Erden Güner
Email: arzu_erden@hotmail.com
ORCID: 0000-0002-8698-7648

Ali Faruk Özyaşar
E-mail: alifaruk1@gmail.com
ORCID: 0000-0002-5396-9486

Murat Topbaş
E-mail: murattopbas@yahoo.com
ORCID: 0000-0002-5396-9486

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BODY AWARENESS LEVEL OF PEDIATRIC PHYSIOTHERAPISTS AND ITS RELATIONSHIP WITH THEIR BODY STRUCTURE AND FUNCTIONS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The physical and psychological loads that physiotherapists working in the field of pediatric rehabilitation are exposed to during therapy sessions can lead to limitations in body structure and functions that exceed the stress threshold. Examining the relationship of pediatric physiotherapists' body awareness with body structures and functions can reveal the effects of loads they are exposed to on their body-mind connection. This study aims to examine the relationship of body awareness of physiotherapists working in pediatric rehabilitation with their body structure and functions.

Method: The study included 100 pediatric physiotherapists. The participants' level of body awareness was assessed by the Body Awareness Questionnaire (BAQ). The exposed forces, mental functions and dynamic balance were evaluated using the Physiotherapist Occupational Injury Questionnaire (POIQ), the Warwick Mental Well-Being Scale (WEMWBS), and the Functional Reach Test (FRT), respectively. Trunk, upper extremity, chest cage flexibility were assessed and Body Mass Index (BMI) were also calculated.

Results: The participants had a mean age of 28.25±3.715 (min-max:23-41). A significant relationship was found between the levels of body awareness and mental well-being (r=0.217; p=0.003). The BAQ, BAQ-1 and BAQ-2 and WEMWBS scores were correlated (p<0.05). There were no relationships between body awareness and trunk, upper extremity, chest flexibility, dynamic balance, and BMI (p>0.05).

Conclusion: The levels of body awareness among pediatric physiotherapists, who work in a profession relying on both mental and physical strength, are directly associated with their mental well-being.

Keywords: Awareness, Balance, Body Mass Index, Flexibility, Physiotherapist.

PEDİATRİK FİZYOTERAPİSTLERİN VÜCUT FARKINDALIK DÜZEYLERİ VE VÜCUT YAPI VE FONKSİYONLARI İLE İLİŞKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Pediatrik rehabilitasyon alanında çalışan fizyoterapistlerin terapi seansları sırasında maruz kaldıkları fiziksel ve ruhsal yükler vücut yapı ve fonksiyonlarında stres eşiğini aşan kısıtlılıklara yol açabilmektedir. Pediatrik fizyoterapistlerin vücut farkındalıklarının vücut yapıları ve fonksiyonları ile ilişkisini incelemek, maruz kaldıkları yüklerin vücut-zihin bağlantıları üzerindeki etkilerini ortaya çıkarabilir. Bu çalışma, pediatrik rehabilitasyonda çalışan fizyoterapistlerin vücut farkındalıklarının vücut yapıları ve fonksiyonları ile ilişkisini incelemeyi amaçlamıştır.

Yöntem: Çalışmaya 100 pediatrik fizyoterapist dahil edildi. Katılımcıların beden farkındalık düzeyleri Beden Farkındalığı Anketi ile değerlendirildi. Maruz kaldıkları kuvvetler, mental iyilik durumları ve dinamik denge durumları sırasıyla Fizyoterapistlerin Mesleki Yaralanma Anketi (FMYA), Warwick Mental İyi Oluş Ölçeği (WMİOÖ) ve Fonksiyonel Uzanma Testi ile değerlendirildi. Gövde, üst ekstremite, göğüs kafesi esneklikleri ölçüldü ve Vücut Kütle Indeksi (VKİ) de hesaplandı.

Sonuçlar: Katılımcıların yaş ortalaması 28,25±3,715 (min-maks:23-41) idi. Beden farkındalık düzeyleri ile mental iyilik hali arasında anlamlı ilişki bulundu (r=0,217; p=0,003). VFA alt boyutlarından VFA-1 ve VFA-2, WMİOÖ puanı ile ilişkiliydi (p<0,05). Beden farkındalığı ile gövde, üst ekstremite, göğüs esnekliği, dinamik denge ve VKİ arasında ilişki yoktu (p>0,05).

Tartışma: Hem mental hem de fiziksel güce dayalı bir meslekte çalışan pediatrik fizyoterapistlerde beden farkındalığı düzeyleri mental iyilik halleri ile doğrudan ilişkilidir.

Anahtar Kelimeler: Beden Kütle İndeksi, Denge, Esneklik, Farkındalık, Fizyoterapist.

INTRODUCTION

Physiotherapists working in the field of pediatric rehabilitation are experts in the evaluation, identification, diagnosis, and treatment of movement disorders and physiological problems. They carry out a comprehensive treatment process aimed at normalizing limitations caused by physical, mental, sensory, and cognitive problems occurring between the newborn and adolescent stages. The rehabilitation process typically continues throughout a child's life, focusing on orthopedics, congenital malformations, neurology, neuropsychiatry, respiratory, and premature conditions (1). Physiotherapists working in this field perform a series of activities that require physical and mental strength including lifting, transfer activities, direct contact with the patient, and manual approaches (2). It is a profession that is open to physical and mental injury due to professional responsibilities such as being in direct contact with the patient, prolonged exposure to certain positions, intense working conditions, direct communication with the child and family in solving the problems experienced by a disabled child, and multidisciplinary management of this process (3,4). It is important to evaluate the physical and mental states of physiotherapists working in the field of pediatric rehabilitation and to reveal its relationship with body awareness, which is a key concept in body-mind interaction, in defining the measures to be taken for occupational injuries.

Body awareness is the ability to perceive the physical and mental states occurring in one's body (5). It is provided through proprioceptive, interoceptive, exteroceptive, and vestibular sensory inputs. Thanks to these inputs, an individual forms a body image based on the feedback acquired about their body. Therefore, changes in the body's structure and functions can impact body awareness directly. The International Classification System of Functioning and Disability (ICF) evaluates body structures and functions as a whole with physical and mental components in a biopsychosocial framework (6).

Body awareness is related to body structures and functions due to its physical, emotional, and social dimensions. In ICF core sets, there are parameters related to flexibility, anthropometric evaluations, balance, and mental well-being in body structure and functions. Body awareness refers to the ability to evaluate various components, which can effectively protect and enhance the professional performance of physiotherapists, their interactions with patients, and their overall health. Also, these assessments can be beneficial in explaining body awareness when associated with personal factors such as occupation, injury history, and providing information about both physical and mental states. Studies examining the relationship between body awareness and these parameters are available in the literature (7,8); however, the effect in occupational branches has been examined very limitedly. It has been demonstrated that the injury management skills of dancers are related to body awareness (9). Occupational injuries and body awareness of physiotherapists have not been investigated deeply. Tekeli et al. examined the occupation-related musculoskeletal disorders of physiotherapists working in different fields and reported that this load was higher in physiotherapists working in pediatric rehabilitation than in other fields (4). In this respect, the working conditions of individuals and the differences in the physical and mental loads they are exposed to make it necessary to examine body awareness about occupation. This situation suggests that job-related differences, and physical and mental experiences may have different effects depending on occupations (10,11). Physiotherapists working in the field of pediatric rehabilitation may experience emotional exhaustion and burnout because they also work intensively with children's families. Studying the relationship between body awareness and structure and function may help physiotherapists to improve their stress coping skills, maintain emotional health, and provide better support to patients and their families.

The negative impact of occupational injuries on mental functions is too significant to be denied (12,13). It has been demonstrated that increasing body awareness reduces stress and burnout, and promotes positive attitudes in healthcare professionals (14,15). Mental impact also affects body structures. In this respect, the relationship between flexibility, balance, body mass index, and body awareness is an issue that needs to be evaluated

as a whole. On the other hand, revealing the physical effects of body awareness is very important in protecting the health of those engaged in professional processes. However, there is no study in the literature investigating body awareness specifically among physiotherapists working in pediatric rehabilitation. In this respect, the study has aimed to examine the relationship between body awareness levels of physiotherapists working in the field of pediatric rehabilitation and body mass index, balance, flexibility, muscle shortness, exposed forces, and mental well-being. The results of the study may also contribute to the development of training programs and interventions that will help physiotherapists working in the field of pediatric rehabilitation to improve body awareness and reduce work-related physical and emotional impact.

METHODS

The study is a descriptive research design and was conducted between April 2022 and January 2023. It was approved by Karadeniz Technical University Scientific Research Ethics Committee with the decision numbered 24237859-312 dated 29.04.2022.

A total of 100 volunteer pediatric physiotherapists (39 females and 61 males), aged between 23 and 50 years, with at least one year of experience in the field of pediatric rehabilitation, had not undergone surgery in the last year, were not pregnant, had no history of acute trauma, did not receive psychiatric treatment, and did not have an infectious and malignant tumoral disease, were included in the study. Participants were informed about the study before the evaluation and signed the informed consent form.

Sociodemographic characteristics (age, gender, years of experience, and the number of weekly session hours) were recorded. The Body Awareness Questionnaire (BAQ) was used to measure body awareness levels, a form adapted from the Physiotherapist Occupational Injury Questionnaire (POIQ) was used to determine the burdens physiotherapists are exposed to, the Functional Reach Test (FRT) was used to measure the relationship between body awareness and dynamic balance states from bodily processes, and Warwick Mental Well-Being Scale (WEMWBS) was used to evaluate the relationship between body awareness and mental well-being from mental functions. To determine the relationship between body awareness and body structure, trunk, upper extremity; rib cage flexibilities were measured. Body mass index (BMI) was calculated by dividing body weight by the square of height and grouped according to the World Health Organization Classification system. Below 18.5 kg/ m^2: Underweight, between 18.5 - 24.9 kg/ m^2: Normal weight, 25 - 29.9 kg/ m^2: Overweight, between 30 - 39.9 kg/m^2: Obese, over 40 kg/ m^2: Severely obese (morbidly obese)" (16).

Data Collection

Occupational Injury of the Physiotherapists: Since there is no reliable and validated questionnaire in Turkish, the type, area and frequency of the occupational injuries and exposed forces were assessed using a form adapted from the Physiotherapist Occupational Injury Questionnaire (POIQ) developed by Holder et al. in 1999 (10).

Body Awareness Questionnaire (BAQ): The 18-item questionnaire developed by Shields et al. in 1989 was developed to determine the level of normal or abnormal sensitivity. BAQ consists of 4 sub-dimensions. These are changes in body process (BAQ-1), sleep-wake cycle (BAQ-2), prediction of onset of illness (BAQ-3), and prediction of body reactions (BAQ-4), and each item is scored on a 7-point Likert scale. A higher total score indicates better body awareness. The Turkish validity and reliability of the scale were shown by Karaca and Bayar (2021) (17).

Warwick-Edinburg Mental Well-Being Scale (WEMWBS): The 14-itemed scale was developed by Tennant and colleagues in 2007 to measure spiritual well-being. The items are scored on a 5-point scale (1: strongly disagree, 2: disagree, 3: slightly disagree, 4: agree, 5: strongly disagree). The total score is between 14-70, where higher scores indicate better mental well-being. Turkish adaptation of the scale was performed by Keldal (18).

Physical Measurement Procedures

Flexibility is the ability of joints to move at large angles and increased flexibility is directly related to improved mobility and reduced risk of injury. Muscles that do not have sufficient flexibility can cause shortening and mechanical low back pain. Evalua-

tion of flexibility and shortness of upper extremity and thoracic muscles, which are frequently used in pediatric rehabilitation, is important in terms of injury risk (19). While flexibility can be considered as an element of static balance, dynamic balance refers to the ability to maintain body balance while in motion. Therefore, tests that assess dynamic balance, such as the Functional Reach Test, are important for pediatric physiotherapists to protect their occupational health and provide better service to patients.

Functional Reach Test (FRT): The test developed by Duncan et al. is widely used for dynamic balance assessment (13). The subject is asked to stand sideways on the wall with the shoulder 90 flexed, elbow extended, and fist closed without touching the wall with the arm on the wall side. The assessor marks the level of the 3rd metacarpal head on the wall. The person is asked to lie forward with feet steady while maintaining balance. The location of the 3rd metacarpal head is marked again. The distance between the first and last position is measured. The average of the last two trials is taken (19).

Trunk Flexion and Hamstring Length: The person stands on a block with a height of 15 cm. They attempt to touch their toes without bending their knees. Flexibility of the lumbar region, hamstring muscles, and gastrocnemius muscle are evaluated with the test. The distance between the fingertip and the wooden block surface is measured by using a tape, and values below the block surface are recorded as positive, while values above as negative in centimeters (16).

Trunk Hyperextension Flexibility: While the person stands facing the wall with the pelvis and torso in full contact with the wall, the distance between the wall and the sternal notch is measured. The pelvis is supported, and the trunk is asked to bend backward from the waist. The distance between the sternal notch and the wall is measured again, and by subtracting this value from the initial measurement, the extent of the movement is recorded in centimeters (16).

Trunk Lateral Flexion Flexibility: While the person is standing with arms straight next to the trunk, the 3rd fingertip projection on both sides is marked on the body. The test is repeated separately on both sides. First, it is asked to tilt the trunk to one side. The imprint of the third fingertip is marked, and the distance between the first imprint and this one is noted in centimeters. During the test, it is important not to lead to flexion, hyperextension, and rotation of the trunk (16).

Trunk Rotation Flexibility: The initial distance between the shoulder and the wall is measured while the person to be evaluated facing the wall and the pelvis is in full contact with the wall. While one shoulder and pelvis maintain contact with the wall, the distance of the other shoulder from the wall is measured and the initial value is subtracted from the final value and recorded in centimeters (16).

Thoracic Cage Flexibility: To assess thoracic cage flexibility, the difference in axillary, epigastric, and subcostal circumference is recorded with an inflexible tape measure while the person is standing upright on feet and arms abducted at maximal inspiration and maximal expiration (20).

Statistical Analysis

In the study, the collected data has been analyzed by using the IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Mean, standard deviation, frequency, and percentage values have been calculated by benefiting from the descriptive statistics. The Kolmogorov-Smirnov test was used to determine whether the data were normally distributed. Pearson's correlation analysis has been used to analyze the relationship between body awareness level and loads, anthropometric measurements, dynamic balance, and mental well-being for normally distributed data and Spearman's correlation analysis has been used for non-normally distributed data. For all data, $p<0.05$ has been accepted as a significance level.

To calculate sample size studies examining the relationship between body awareness and emotional state were taken as reference since there is no study in the literature examining the relationship between similar parameters in pediatric physiotherapists. A positive relationship was found between body awareness level (BAQ) score and emotional state (Beck Depression Inventory) in the study of Kalkışım et al. ($r = 0.127$, $p = 0.030$)

Table 1. Distribution of Sociodemographic Data

Variables	**n (%)**
Gender	
Female	39 (39)
Male	61 (61)
Body Mass Index Classification	
Underweight	3 (3)
Normal	64 (64)
Overweight	29(29)
Obese	4 (4)
Experience classification (years)	
1-5	36 (36)
5-10	10 (10)
More than 10	54 (54)
	Mean ± SD
Age	28.2 ± 3.7
Experience (years)	4.7 ± 3.2
BMI	23.68 ± 3.386
Height length (cm)	173.41 ± 9.360
Body weight (kg)	71.38 ± 14.034

BMI: Body Mass Index; cm: centimeter, kg: kilogram, n: Number; SD: Standard Deviation; %: Percent.

(21). A significant relationship was found between body awareness level and performance emotional states in athletes in a different study (r = .47, P < .01). For our study to be closest to the sample group and parameters, the study of Kalkışım et al. was taken as reference and it was predicted that there would be a relationship of around r = 0.30 between mental well-being and body awareness level G*power version 3.0.10 (Axel Buchner, Universität Kiel) was used for sample calculation. Correlation p H1: 0.5477 was calculated. In this case, it was calculated to be at least 37 people. However, since there were also sub-dimensions of the BAQ in the study, this number was determined as at least 100 people for a descriptive study.

Table 2. Distribution of Measured Data

Variables	**Mean ± SD**	**Min-Max**
Patient contact time (hours)	35.6 ± 10.7	6-60
Number of injuries (times)	2.4 ± 1.3	1-8
Number of injured sites	5.6 ± 2.4	1-8
BAQ	94.5 ± 14.5	52-124
BAQ-1	31.4 ±5.4	14-42
BAQ-2	36.5 ± 6.9	19-49
BAQ-3	34.0 ± 6.4	8-45
BAQ-4	20.4 ± 4.6	4-29
WEMWBS	50.3 ± 13.1	14-140
FRT	30.2 ± 9.3	11-49

BAQ: Body Awareness Questionnaire, BAQ-1: Attention to changes in body process and responses, BAQ-2: Prediction of body responses, BAQ-3: Awareness of sleep-wake cycle, BAQ-4: Prediction of illness onset, WEMWBS: Warwick Mental Well-Being Scale, FRT: Functional Reach Test, SD: Standard Deviation, Min: Minimum, Max: Maximum.

Table 3. Analysis of the Relationship between Body Awareness and Exposed Loads

Exposed powers	BAQ		BAQ-1		BAQ-2		BAQ-3		BAQ-4	
	r	p	r	p	r	p	r	p	r	p
Weight lifting	0.50	0.685	0.02	0.862	-0.10	0.396	0.02	0.865	-0.04	0.767
Staying in the same position for a long time	0.03	0.835	-0.10	0.396	-0.09	0.445	-0.02	0.849	-0.01	0.983
Manual Therapy	-0.01	0.921	-0.01	0.912	-0.15	0.220	-0.01	0.954	0.01	0.956
Repetitive Motion	0.12	0.328	0.04	0.714	-0.07	0.559	0.07	0.581	0.09	0465
Overhead Activities	0.01	0.914	-0.03	0.832	-0.01	0.929	-0.09	0.441	-0.01	0.936
Reach	0.05	0.671	-0.02	0.851	-0.09	0.423	-0.08	0.508	0.01	0.953
Climbing Stairs	0.06	0.594	0.05	0.680	0.06	0.605	0.12	0.311	0.09	0.452
Crouching	0.13	0.278	0.12	0.315	0.03	0.792	0.26	**0.032***	0.08	0.520
Walking	0.02	0.867	0.06	0.631	-0.03	0.834	0.14	0.245	0.04	0.764
Working in an unsuitable or confined space	0.06	0.621	-0.15	0.226	0.05	0.676	0.01	0.907	-0.06	0.615
Patient Transfer	0.09	0.479	-0.04	0.760	0.02	0.869	0.07	0.548	0.09	0.429
Number of body regions exposed to injury	0.06	0.611	0.01	0.964	-0.09	0.453	0.01	0.957	0.15	0.189
Patient contact time	0.04	0.650	0.09	0.360	0.18	0.063	0.2	0.120	0.08	0.416
Professional experience	0.10	0.303	0.08	0.408	0.11	0.253	0.031	0.760	0.07	0.471

BAQ: Body Awareness Questionnaire, BAQ-1: Attention to changes in body process and responses, BAQ-2: Prediction of body responses, BAQ-3: Awareness of sleep-wake cycle, BAQ-4: Prediction of illness onset.

RESULTS

The 39% of the participants were female and 61% were male, aged between 23-41 (min-max) years. Their professional experience ranged between 1-16 years. Nineteen percent of the participants had a musculoskeletal injury once in the last 2 years, 54% had a musculoskeletal injury more than once, and 27% had no injury at all. The injured body regions were distributed as in the follwing: only upper extremity (16%), only lower extremity (8%), spine (7%), both lower and upper extremity (4%), both lower extremity and spine (4%), both upper extremity and spine (41%), both lower and upper and spine (19%). Thirty two percent of those who had injuries consulted a doctor and 67.6% did not. The places where the injuries occurred were; 22.5% private hospitals, 5.6% state hospitals, 69% private education and rehabilitation centers, and 2.8% different environments. Sociodemographic data is shown in Table 1.

The average weekly patient contact time of the participants was 35.6±10.6 hours. The average injury frequency was 2.3±1.25 per two years. The average number of injured regions was 5.6±2.4. The distribution of measurement data related to patient contact time, number of injuries and number of injured sites is given in Table 2.

A very weak relationship was found between sleep-wake cycle awareness (BAQ-3) and crouching, one of the forces exposed (r=0.255; p=0.03). No correlation was found among exposed forces and other body awareness sub-dimensions (p>0.05) (Table 3).

The total score of the BAQ and sub-dimensions

Table 4. Analysis of the Relationship Between Body Awareness and Mental Well-Being

	BAQ		BAQ-1		BAQ-2		BAQ-3		BAQ-4	
	r	p	r	p	r	p	r	p	r	P
WEMWBS	0.27**	**0.030**	0.26**	**0.008**	0.29**	**0.040**	0.22*	0.280	0.74	0.465
FRT	-0.10	0,288	-0.05	0.608	-0.04	0.658	-0.18	0.067	-0.02	0.825

BAQ: Body Awareness Questionnaire, BAQ-1: Attention to changes in body process and responses, BAQ-2: Prediction of body responses, BAQ-3: Awareness of sleep-wake cycle, BAQ-4: Prediction of illness onset WEMWBS: Warwick Mental Well-Being Scale. FRT: Functional Reach Test.

Table 5. Analysis of the Relationships Between Body Awareness and BMI and Trunk Flexibility Measurements

Body Awareness	BAQ	
	r	p
BMI (kg/m²)	-0.04	0.663
Trunk flexion (thirty-flexion test) (°)	-0.04	0.715
Trunk hyperextension flexibility (°)	-0.07	0.488
Trunk lateral flexion flexibility right (°)	-0.02	0.856
Trunk lateral flexion flexibility left (°)	-0.03	0.752
Body rotation flexibility right (°)	-0.02	0.882
Flexibility of trunk rotation left (cm)	0.17	0.178
Thoracic Cage Flexibility (cm)		
Axillary (DI-DE) (cm)	-0.11	0.285
Subcostal (DI-DE) (cm)	0.01	0.922
Epigastric (DI-DE) (cm)	0.05	0.624

DI: Deep inspiration, DE: Deep expiration; BMI: Body Mass Index., cm: centimeter, kg: kilogram, (°): derece, BAQ: Body Awareness Questionnaire.

were not significantly correlated with the number of regions exposed to injury, patient contact time, and professional experience (p>0.05) (Table3).

A low-level significant correlation has been found between BAQ and WEMWBS total scores (r=0.217; p<0.05). In terms of sub-dimensions, the relationship between BAQ-1 (attention to changes in body process and responses), BAQ-2 (sleep-wake cycle) and WEMWBS was significant (p<0.05). No significant relationship was found between BAQ-3 (prediction of onset of illness) and BAQ-4 (prediction of body reactions) and WEMWBS scores (p>0.05) (Table 4).

The BAQ was not correlated with FRT (r=-0.107; p= 0.288), as well as with the areas exposed to injury (p>0.05) (Table 4).

There was no significant correlation between the BAQ and BMI, trunk flexibility, and thorax flexibility (p>0.05) (Table 5).

DISCUSSION

Body awareness is a key factor in explaining the mental effects of bodily processes. Since occupational exposure affects the body and mind negatively as a whole, it is important to reveal the relationship between body structure and functions and body awareness. In this study, it has been found that the body awareness levels of physiotherapists working in the pediatric rehabilitation field, where there is a high level of physical and mental workload, are associated more with mental well-being than physical parameters.

A limited number of studies have been found in the literature regarding the workload physiotherapists are exposed to. In the related literature, mostly physical injuries were examined. Salik et al. found that musculoskeletal injuries of physiotherapists were mostly in the waist, wrist, shoulder, and neck regions. The most common factor causing injury has been patient transfer (22). Vieira et al. reported manual therapy techniques as the most common factor causing injury in the waist, neck, and back regions (23). This condition has been found to have both the upper extremities and the spine being highly injured areas. This result has shown that physiotherapists working in the field of pediatric rehabilitation were mostly affected by the structures and functions in the upper extremities and spine. In addition, Iqbal et al. reported that the quality of life of physiotherapists decreased at a rate of %71 due to pain problems after they started their profession (24). In this study, the rate of suffering at least one injury within 2 years after starting the profession was found to be 19%, and the rate of suffering more than one injury was 57%. This result has shown that physiotherapists working in the field of pediatric rehabilitation are vulnerable to injury.

The amount of the exposed load varies according

to profession. A study conducted in Nigeria reported that musculoskeletal disorders were common among physiotherapists. It has been suggested that weightlifting, patient transfers, and manipulation are the methods that physiotherapists are frequently exposed to, and they cause these injuries (2, 25).

In this study, it has been determined that there was no relationship between body awareness levels and BMI of physiotherapists working in the field of pediatric rehabilitation. More studies are needed to discuss this relationship in different BMI groups. Tekeli et al. reported that the most common cause of injury in physiotherapists working with children was using flexion and rotation postures and staying in the same position for a long time (4). They also found that patient guidance transfer, repetitive motion, and staying in the same position for a long time to be the most common causes of injury in physiotherapists working in the field of pediatric rehabilitation. It has revealed that pediatric physiotherapists were exposed to challenging activities with high intensity. On the other hand, those who were frequently exposed to squatting activity were found to have higher body awareness in the sleep-wakefulness sub-dimension. It is related to the results of Vatansever et al. which revealed the relationship between physical activity level and body awareness (26).

The relationship between body awareness and anthropometry is one of the popular research areas. However, there has been no definite consensus in the literature. In the literature, the relationship between body awareness and BMI has been examined in a healthy population and there has been no definite consensus. Kalkışım et al. found that body awareness was not related to BMI in university students. They also found relationships between circumference measurements and sub-dimensions of body awareness level (21). Erden and Emirzeoğlu found a relationship between body awareness level and height (27). In a different study, no significant relationship was found between body awareness levels and age, anthropometric measurements, and body composition of adult individuals (28). Also in our study, there was no relationship between BMI and BAQ. The relationship between chest cage flexibility and body awareness was also not significant. This may be due to the low number of overweight and obese participants in this study. Our results have provided new data investigating the relationship between chest circumference measurements and body awareness. This study has contributed to the literature by providing data on the relationship between rib cage flexibility and body awareness in an area that has not been studied before. These data can form the basis for future research and help to understand the subject more deeply.

Mental and emotional states vary due to differences in working conditions (29,30). In one study, pediatric physiotherapists were found to have similar burnout levels although their working hours were lower than other occupational groups (psychologists and teachers) (31). In another study in which body awareness, physical activity, depression, and the quality of life of young adults were examined, it was found that participants with relatively high body awareness had fewer mood disorders (32). In a study conducted on athletes, a relationship was found between body awareness levels and emotional states (27). On the other hand, clinical studies show that body awareness affects emotional state. In a study conducted with the hypothesis that an increase in body awareness in patients with heart failure or after transplantation may help individuals recognize worsening heart failure symptoms earlier, no significant difference was found between age, gender, and treatment group in terms of body awareness. In addition, no significant relationship was found between body awareness and negative moods such as anxiety, depression, or anger (33). The relationship between body awareness and emotional state in different populations has been shown in a limited number of studies, but this relationship needs to be investigated in terms of occupational characteristics.

The relationship between body awareness and balance has been examined in the literature but it has not been implemented in different occupations. In another study which examined the relationship between body awareness and balance-related fall risk, body awareness of the group with low fall risk was found to be significantly higher than the others (8). In another study, no relationship was found between body awareness and balance in healthy individuals with different physical activity levels

(26). In this study, no relationship was found between dynamic balance and body awareness level. For the FRT, 15 cm and above indicates a low fall risk (19). In this study, the FRT (30.2 ± 9.3 cm) and BAQ scores (94.5 ± 14.5) of physiotherapists working in the field of pediatric rehabilitation were above the average. This may be due to the young mean age and low experience year in the profession of the study sample. Also, we think that the absence of this relationship could be related with the characteristic of the BAQ which does not include parameters related to balance and posture. It has been revealed that the body awareness levels of physiotherapists working in the pediatric rehabilitation field, a profession relying on mental and physical strength, are directly associated with their mental well-being. This result has shown that body awareness levels of pediatric physiotherapists are related to psychosocial functions rather than body structures such as BMI, upper extremity muscle shortness, trunk flexibility, and dynamic balance.

The study has two limitations. The first limitation is the insufficient number of participants in different BMI and professional experience groups. The relation of body awareness and occupational injury may vary according to different BMI and professional experience of the physiotherapists. The second limitation was that, the relationships between the parameters were examined statistically using only correlation analyses. In further studies, regression analysis methods can be used to examine causal relationships.

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Aarti GUPTA, PhD, PT[1]
Siddhartha SEN, Professor, PhD, PT[2]

THE EFFECT OF PELVIC CONTROL EXERCISES ON STANDING POSTURE IN CHILDREN WITH SPASTIC DIPLEGIC CEREBRAL PALSY: A PILOT RANDOMIZED CONTROLLED TRIAL

ORIGINAL ARTICLE

ABSTRACT

Purpose: Pelvic instability is a common finding in children with spastic diplegic cerebral palsy (CP). Mobility and day-to-day functioning are impeded by improper muscle activation and inadequate regulation of movement around the pelvis. The study's objective was to investigate the effects of pelvic control exercises on posture of children with spastic diplegic CP.

Methods: 24 spastic diplegic children with CP who participated in this single-blind trial were divided into two groups at random by simple random sampling. Group A (n = 12) received conventional intervention and pelvic control exercises, while Group B (n = 12) received only conventional intervention. For a period of eight weeks, the intervention was carried out three days a week. Postural angles like thoracic inclination (TI), trunk angle (TA), pelvic tilt (PT), lumbar angle (LA), lumbar curve (LC), horizontal alignment of anterior superior iliac spine (HAASIS), horizontal alignment of posterior superior iliac spine (HAP) were evaluated as outcome measure before and after the intervention is finished. While the independent t test was used to examine differences between the two groups, the paired-t test was employed to examine differences within the group.

Results: When outcome measures from both groups were compared prior to treatment, no significant differences were observed. The values of postural angles in study group A showed a significant improvement after the treatment with conventional physiotherapy and pelvic control exercises in comparison with conventional treatment alone. Angles of TA (p=0.030) and LC (p=0.007) increased while those of TI (p=0.027), PT (p<0.001), LA (p=0.005), HAASIS (p=0.054), and HAP (p=0.017) decreased in group A resulting in better trunk and pelvic alignment.

Conclusion: The results indicated that pelvic control training could be beneficial in improving posture of children with spastic diplegic CP.

Keywords: Cerebral Palsy, Diplegia, Pelvis, Posture, Spasticity

SPASTİK DİPLEJİK SEREBRAL PALSİLİ ÇOCUKLARDA PELVİK KONTROL EGZERSİZLERİNİN AYAKTA DURMA ÜZERİNE ETKİSİ: PİLOT RANDOMİZE KONTROLLÜ ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Pelvik instabilite, spastik diplejik serebral palsili (SP) çocuklarda sık görülen bir bulgudur. Hareketlilik ve günlük işlevsellik, uygunsuz kas aktivasyonu ve pelvis çevresindeki hareketin yetersiz düzenlenmesi nedeniyle engellenir. Çalışmanın amacı spastik diplejik SP'li çocuklarda pelvik kontrol egzersizlerinin postür üzerine etkilerini araştırmaktı.

Yöntem: Bu tek-kör çalışmaya katılan SP'li 24 spastik diplejik çocuk, basit rastgele örnekleme yoluyla rastgele iki gruba ayrıldı. Grup A'ya (n=12) geleneksel müdahale ve pelvik kontrol egzersizleri yapılırken, Grup B'ye (n=12) yalnızca geleneksel müdahale uygulandı. Sekiz hafta boyunca müdahale haftada üç gün gerçekleştirildi. Torasik eğim (TI), gövde açısı (TA), pelvik eğim (PT), lomber açı (LA), lomber eğri (LC), anterior superior iliak omurganın yatay hizalaması (HAASIS), posterior superior iliak yatay hizalaması gibi postüral açılar omurga (HAP), müdahalenin bitiminden önce ve sonra sonuç ölçüsü olarak değerlendirildi. İki grup arasındaki farklılıkları incelemek için bağımsız t testi, grup içi farklılıkları incelemek için eşleştirilmiş t testi kullanıldı.

Sonuçlar: Her iki grubun sonuç ölçümleri tedavi öncesinde karşılaştırıldığında anlamlı bir fark gözlenmedi. A çalışma grubundaki postüral açı değerleri, konvansiyonel fizyoterapi ve pelvik kontrol egzersizleri ile yapılan tedavi sonrasında, tek başına konvansiyonel tedaviye kıyasla anlamlı bir iyileşme gösterdi. TA (p=0,030) ve LC (p=0,007) açıları artarken, TI (p=0,027), PT (p<0,001), LA (p=0,005), HAASIS (p=0,054) ve HAP (p=0,017) grup A'da düşüş gösterdi ve bu da daha iyi gövde ve pelvik hizalanma sağladı.

Tartışma: Sonuçlar, spastik diplejik SP'li çocuklarda pelvik kontrol eğitiminin postürün iyileştirilmesinde faydalı olabileceğini gösterdi.

Anahtar Kelimeler: Serebral Palsi, Dipleji, Pelvis, Duruş, Spastisite

1 *Scholar, Department of Physiotherapy, SGT University, Gurugram, India.*
2 *Department of Physiotherapy, SGT University, Gurugram, India.*

Correspondence (İletişim):

Aarti Gupta, PhD, PT
SGT University, Department of Physiotherapy, Gurugram, India. E-mail: physioaarti@gmail.com, ORCID: 0000-0003-0637-8656

Siddhartha SEN
E-mail: siddhartha_fphy@sgtuniversity.org
ORCID: 0000-0002-5269-5639

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INTRODUCTION

Cerebral palsy (CP), the most prevalent reason for physical impairment in children, can affect the child's health in a variety of ways. Primary neuromuscular deficiencies, including reduced selective motor control, muscle weakness, and spasticity, are among the motor signs of CP, while secondary musculoskeletal issues include bony malformations and contractures (1). The most common form of CP is spastic diplegia, which affects 80% of preterm infants and accounts for approximately 44% of the overall incidence of CP (2). The trunk is noticeably weaker and the extremities are highly spastic in children with spastic diplegia. In comparison to their lower extremities, they demonstrate milder motor impairment in their upper extremities (3). The primary functional issue is poor posture and movement. Appropriate alignment of each body component and spinal segment with the trunk and neighbouring part is necessary for an upright posture (4). Children with CP typically have an abnormal alignment of the spine in comparison to children who are developing normally (5).

The pelvic girdle connects the upper and lower quadrants of the musculoskeletal system anatomically and transmits forces between them, affecting and being influenced by these segments (6). A deficiency in the motor process, manifested as spasticity or weakness in the muscles around the pelvis, results in an aberrant pelvic position (7). As hip movements are limited in children with spastic CP, pathologic motion of the pelvis occurs either with excessive motion or asymmetric motion (8). Some children with CP have spastic hamstring muscles, which cause the pelvis to tilt backward (posteriorly), preventing anterior tilt. On the other hand, some children may exhibit greater hip flexor spasticity, pushing the pelvis into an anterior tilt and preventing posterior tilt (9). These irregularities in the spine lead to changes in postural angles, such as LA, TA, and PT, because of an imbalance between the postural and muscular forces operating on the growing axial skeleton.

Currently, the examination and treatment of the upper and lower extremities are the main topics of research in children with CP (10). Contrarily, there is little research on pelvic control in children with CP. Only one study has mentioned pelvic stabilisation program in spastic CP (11) while other studies have been done in stroke population (12). In contrast to limb muscles, the abdominal muscles require a stable origin to function well. Depending on which section of the trunk is being moved, this origin can be the pelvis, thorax, or central aponeurosis. The mobility over stability task that is necessary for all functional movements is counterrotation between the upper and lower trunks (13). Control of the muscles around the pelvis should be one of the main areas of concentration for enhancing motor performance because it is hypothesised that providing a more stable base of support would enable more regulated and directed movement. The purpose of this study is to examine the impact of pelvic control exercises on standing posture in children with diplegic CP.

METHODS

Study Design

Between August 2023 and December 2023, a pilot pretest-posttest, parallel-group, single blinded, randomised controlled experiment was undertaken. The SGT Medical College Hospital and Research Institute and Khushboo Welfare Society, both in Gurugram, Haryana, conducted this study. The university's ethics committee (SGT University, Departmental Ethical Committee, Faculty of Physiotherapy) gave the study approval (SGTU/FPHY/2022/438, dated 12.10.22), and it was registered with the Clinical Trials Registry of India (ICMR-NIMS) as CTRI/2023/08/055957 and was carried out in compliance with the 1964 Helsinki Declaration. The CONSORT standard for reporting randomised controlled trials has been followed in the reporting of this study (14). All participants and their parents received information about the study's goals and methods, and they all signed informed written consent forms. Their permission for publishing their photographs without disclosing their identity was seeked.

Participants Recruitment, Sample size and Allocation

Children with Spastic Diplegic CP who had been referred by a paediatric neurologist to the Depart-

ment of Physical Therapy's outpatient clinic at SGT University and Khushboo Welfare Society were examined to see which ones could possibly be included in this study. Spastic diplegic children of both genders who met the following criteria were eligible to participate: age groups ranging from 5 to 12 years; motor function at level I or II on the Gross Motor Function Classification System (GMFCS); and spasticity of 1, 1+ or 2 on the Modified Ashworth Scale as assessed by hip adductors, internal rotators, quadriceps, and calf muscles.

Children who had received an injection of botulinum neurotoxins, had lower limb casting within six months, had undergone previous musculoskeletal surgery, had any variation in limb length, any musculoskeletal deformity, participation in any other rehabilitation program, or had attention deficit disorder were excluded.

According to Steven A. Julious's study, we took a sample of 24, as he suggested that pilot studies should examine a minimum of 12 people per group by simple random sampling method (15). The children were asked to select one index card from a box containing 24 cards—12 for each group—to reveal their group membership, and they were then split into two equal groups (A and B) at random in a 1:1 allocation ratio by a person who was not aware of the programs for therapy. Subjects, families, and research personnel were all blinded to treatment allocation. The study physiotherapist was the only person who was not blinded.

Outcome measure

Posture Evaluation

The photographic method was used to assess posture (16). Landmarks were placed on the ground to guarantee that each subject was positioned in front of the camera in the same manner. Digital Nikon DSLR 7100 cameras were used. The cameras were set up 200 cm away from the line indicating the subject's location using three tripods (one in front, one in the back, and one on the subject's right side). A spirit level was used to level it on the stand so that it was perpendicular to the floor. The child's eyes were level with the centre of the Nikon 20 mm wide-angle lens when the tripod's height was adjusted. Anterior superior iliac spine (ASIS), posterior superior iliac spine (PSIS), greater trochanter and spinous process of C7, T12, L3, S2 were all marked on the subject's right side of the body before photographs were taken. Two of these

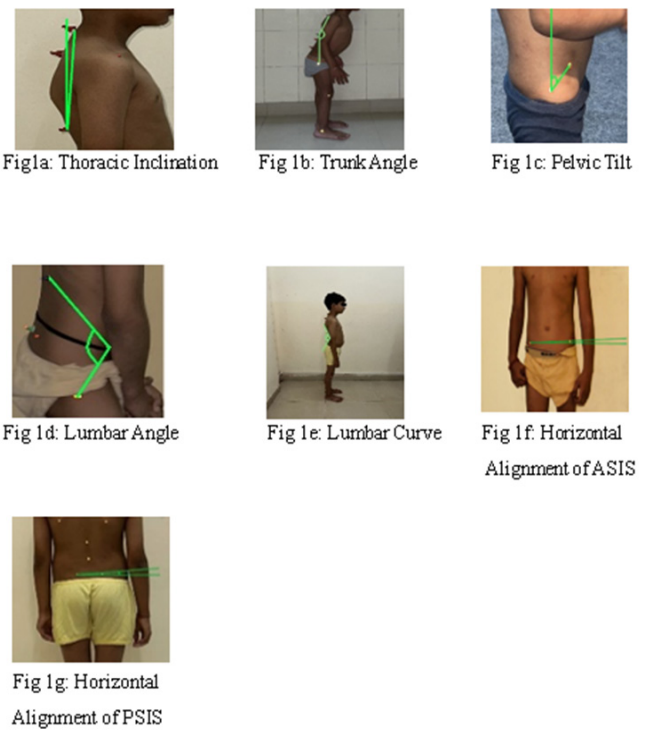

Figure 1. Postural Angles

seven points were bilateral. After the markers were positioned, the participant was instructed to stand in front of the front camera at the assigned spot, face forward, and adopt a comfortable habitual standing stance. The researchers captured three shots of every participant with their feet planted on the ground: a frontal, a back, and a right-side image (17).

For the photogrammetry, the following angles were calculated (Figure 1).

1. Thoracic Inclination (TI)

The line connecting C7 to T12 establishes the angle with respect to the vertical.

2. Trunk angle (TA)

The line between T12 and C7 and the line drawn from T12 to the greater trochanter form this angle.

3. Pelvic tilt (PT)

It is the line drawn from greater trochanter to ASIS with regard to vertical.

4. Lumbar angle (LA)

A line that is drawn through the greater trochanter and ASIS, as well as through T12 and ASIS, produces the lumbar angle.

5. Lumbar curve (LC)

The lumbar curve is formed by a line drawn from T12 and L3 and a line drawn from L3 and S2 (18).

6. Horizontal alignment of ASIS (HAASIS)

It is the angle between the two ASIS and a horizontal line.

7. Horizontal alignment of PSIS (HAP)

It is the angle between the two PSIS and a horizontal line (19).

Each participant's photographs, which included several angles, was put into the video analysis programme Kinovea 0.9.5 (kinovea open source project) (20). The software's cross marker, line, and angle tools were used to examine postural angles. To make the points in the image easier to see, the bone landmarks were highlighted using the cross-marker tool and a bright contrast colour.

While there is scarcity of information regarding values of postural angles, one study had evaluated postural angles in children with spastic diplegia and children with typical development. As a reference to this previous study, it may be concluded that there is remarkable deviation in the postural angles in diplegic CP children as compared to healthy controls (17).

Intervention

Both the study group (A) and control group (B) received conventional exercises for 30 minutes per session, three times per week for eight weeks, while the study group also received pelvic control exercises for 15 minutes per session, three times per week for eight weeks, after the conventional exercises. Pelvic control exercises were done after 2 min of rest period of conventional exercises and on the same days as were conventional exercises. Both groups performed two sets of each exercise with a two minutes interval between sets. An exercise diary was kept to document information regarding the overall number of sessions, the causes of any absenteeism, the incidence of any unfavourable event, and the number of repetitions and therapy adherence delivered fully as planned.

Conventional Exercises

1. Stretching of psoas muscle, hamstrings and gastrocnemius

2. Strengthening of muscle abdominis obliquus, latissimus dorsi and glutei

3. Movement transitions like standing up from a chair

4. Weight shifting and loading of the lower extremities like kicking a ball, reaching in different directions, and picking up objects that are put outside the stability limit (beyond arm's length).

5. Walking exercises such as sideways, backwards, forwards, and obstacle course walking;

6. Moving up and down stairs and ramps

7. Walking through an obstacle course (21)

Pelvic Control Exercises (Appendix-A)

This treatment program was divided into four phases: Initial, Improvement, Advance, and Maintenance. Each phase was of 2 weeks duration (13).

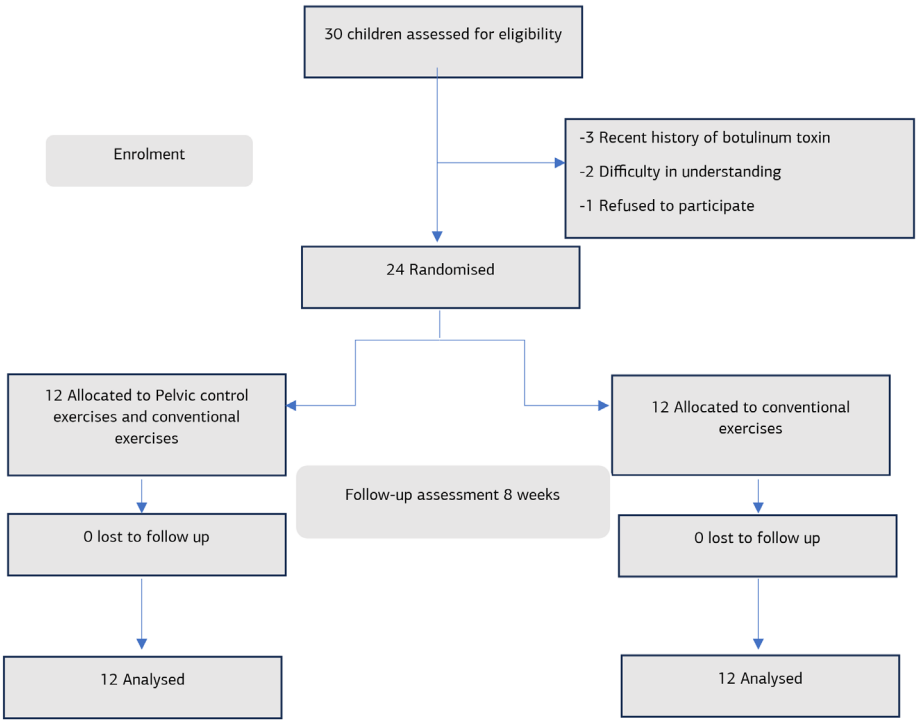

Figure 2. Flow chart of the participants

Initial Phase (Antero-posterior movements of pelvis has been introduced in this phase)

1. Sidelying: Pelvic mobilisation

2. Prone kneeling: Cat-camel exercise

3. Sitting: Weight shifting on swiss ball

4. Lying: Bridging

5. Half kneeling: Diagonal pattern

6. Standing: Posterior tilting exercises while kicking football in front, taking step forward on a low height box. Pelvic stabilisation while maintaining hip-knee in 90-90 position and pelvic facilitation during stance phase.

Improvement phase (Sideways movements of pelvis has been introduced in this phase)

1. Sidelying: Pelvic mobilisation

2. Prone kneeling: Quadruped rocking and selective lateral movement of pelvis

3. Lying: Bridging with hold

4. Half kneeling: Diagonal pattern with heavy object

5. Standing: Lateral tilting of pelvis while kicking football sideways, anterior tilting of pelvis while taking step backwards on a low height box. Pelvic stabilisation while maintaining hip-knee in 90-90 position while carrying an object and pelvic facilitation during swing phase.

Advance phase (Rotatory movements of pelvis has been introduced in this phase)

1. Sidelying: Pelvic mobilisation

2. Sitting: Isolated flexion-extension of pelvis

3. Kneel standing: Weight shifts

4. Lying: Bridging with adductor squeeze

5. Half kneeling: Diagonal pattern with catch and throw ball

6. Standing: Forward rotation of pelvis while kicking football in front, lateral tilting of pelvis while taking step sideways on a low height box. Pelvic stabilisation while maintaining hip-knee in 90-90 position with reach-outs and pelvic facilitation during stance and swing phase on irregular surface.

Maintenance phase (Movements of pelvis in all planes have been introduced in this phase)

Table 1. Baseline Characteristics of the Children with Spastic diplegic CP in the Study

Characteristics	Group A(n=12) Mean± SD	Group B (n=12) Mean ± SD	t value	*p* value
Gender[€]	M=9, F=3	M=8, F=4	0.202	0.653
Age (years)	6.92 ± 3.17	7.42 ± 2.90	-0.40	0.691
Height (m)	1.17 ± 0.21	1.19 ± 0.22	-0.23	0.818
Weight (kg)	26.77 ± 10.11	29.17 ± 11.83	-0.53	0.599
BMI (kg/m^2)	19.68 ± 4.29	19.74 ± 1.88	-0.04	0.961

M: male; F= female; BMI= body metabolic index; SD: Standard Deviation; [€]: Chi-square test

1. Sidelying: Pelvic mobilisation

2. Lying: Rotate upper body away from lower body

3. Sitting: Isolated flexion-extension of pelvis

4. Lying: Bridging with one leg straight

5. Standing: Pelvic tilting with knees bent, weight shifts, pelvic facilitation while kicking football in all directions, pelvic facilitation while taking step in all directions on different height of boxes, pelvic stabilisation while maintaining hip-knee in 90-90 position with reach-outs in different directions and pelvic facilitation during sit to stand (22).

Statistical Analysis

IBM SPSS version 26.0 (SPSS Inc., Chicago, IL, USA) was the program used for data analysis. The Shapiro-Wilk test was used to assess the data distribution. An independent t test was used to compare demographic data between groups at baseline. An independent sample t test was used to assess the postural angles between the groups following the completion of pelvic control training and conventional training. The paired t-test was used for the analysis within the group. For the current study, p values < 0.05 were considered statistically significant.

RESULTS

Data of participants which completed the study (n = 24) was analyzed (Figure 2).

Baseline characters in Table 1 did not show any significant group differences. Thus, baseline characters were consistent.

Table 2 compares the t-value and p-value of the postural angles for Group A and B before and after the intervention. To examine within-group differ-

Table 2. Comparison of Postural Angles within Group A and B

Variables	Group	Baseline	8th week	*t* value	Effect size[CI]	*p* value
		Mean ± SD	Mean ± SD			
TI	Group A	17.02 ± 4.27	10.39 ± 3.20	11.27	1.73 [1.06, 2.40]	<0.001*
	Group B	15.51 ± 4.22	14.20 ± 4.52	3.455	0.29 [-0.27, 0.86]	0.005*
TA	Group A	151.95 ± 7.23	166.96 ± 9.15	-6.65	1.79 [1.11, 2.47]	<0.001*
	Group B	152.96 ± 5.10	158.99 ± 7.64	-4.302	0.91 [0.32, 1.51]	0.001*
PT	Group A	34.42 ± 8.41	22.91 ± 7.53	8.37	1.42 [0.78, 2.06]	<0.001*
	Group B	38.23 ± 4.28	35.70 ± 4.34	9.726	0.58 [-0.00, 1.16]	<0.001*
LC	Group A	163.91 ± 8.77	177.13 ± 9.53	-12.85	1.39 [0.75, 2.02]	<0.001*
	Group B	163.36 ± 8.70	165.63 ± 8.54	-13.718	0.26 [-0.31, 0.83]	<0.001*
LA	Group A	113.35 ± 12.02	102.12 ± 8.27	7.14	1.05 [0.44, 1.65]	<0.001*
	Group B	115.58 ± 8.83	112.53 ± 8.72	10.013	0.34 [-0.23, 0.91]	<0.001*
HAASIS	Group A	4.61 ± 3.58	2.35 ± 2.08	4.78	0.76 [0.17, 1.35]	0.001*
	Group B	5.13 ± 2.31	4.21 ± 2.38	9.256	0.39 [-0.18, 0.97]	<0.001*
HAP	Group A	5.39 ± 3.23	1.71 ± 1.40	6	1.45 [0.81, 2.10]	<0.001*
	Group B	3.94 ± 0.99	2.99 ± 0.97	12.976	0.95 [0.35, 1.55]	<0.001*

TI: Thoracic inclination; TA: Trunk angle; PT: Pelvic tilt; LA: Lumbar angle; LC: Lumbar curve; HAASIS: Horizontal alignment of anterior superior illiac spine; HAP: Horizontal alignment of pelvis; CI: Confidence Interval; *: significant difference

Table 3. Comparison of Postural Angles between the Groups

Variables	Time Frame	Group A	Group B	t value	Effect size [CI]	*p* value
		Mean± SD				
TI	Baseline	17.02 ± 4.27	15.51 ± 4.22	0.865	0.35 [-0.22, 0.92]	0.396
	8th week	10.39 ± 3.20	14.20 ± 4.52	-2.378	0.96 [0.36, 1.56]	**0.027***
TA	Baseline	151.95 ± 7.23	152.96 ± 5.10	-0.396	0.16 [-0.41, 0.73]	0.696
	8th week	166.96 ± 9.15	158.99 ± 7.64	2.316	0.93 [0.33, 1.53]	**0.030***
PT	Baseline	34.42 ± 8.41	38.23 ± 4.28	-1.398	0.56 [-0.02, 1.14]	0.176
	8th week	22.91 ± 7.53	35.70 ± 4.34	-5.1	2.05 [1.34, 2.76]	**<0.001****
LC	Baseline	163.91 ± 8.77	163.36 ± 8.70	0.154	0.06 [-0.50, 0.63]	0.879
	8th week	177.13 ± 9.53	165.63 ± 8.54	3.112	1.25 [0.63, 1.87]	**0.005***
LA	Baseline	113.35 ±12.02	115.58 ± 8.83	-0.516	0.21 [-0.36, 0.78]	0.611
	8th week	102.12 ± 8.27	112.53 ± 8.72	-3	1.20 [0.59, 1.82]	**0.007***
HAASIS	Baseline	4.61 ± 3.58	5.13 ± 2.31	-0.42	0.17 [-0.40, 0.74]	0.679
	8th week	2.35 ± 2.08	4.21 ± 2.38	-2.035	0.82 [0.23, 1.41]	0.054
HAP	Baseline	5.39 ± 3.23	3.94 ± 0.99	1.482	0.60 [0.02, 1.18]	0.152
	8th week	1.71 ± 1.40	2.99 ± 0.97	-2.592	1.05 [0.44, 1.65]	**0.017***

TI: Thoracic inclination; TA: Trunk angle; PT: Pelvic tilt; LA: Lumbar angle; LC: Lumbar curve; HAASIS: Horizontal alignment of anterior superior illiac spine; HAP: Horizontal alignment of pelvis; CI: Confidence Interval; *: significant difference

ences at baseline (before intervention) and week 8 (after intervention), a paired t-test was used. After receiving conventional physical therapy along with pelvic control exercises, the results demonstrated improvement in all postural angles in group A [TA (p<0.001); LC (p<0.001); TI (p<0.001); PT (p<0.001); LA (p<0.001); HAASIS (p=0.001); and HAP (p<0.001)]. Similarly, all postural angles revealed statistically significant difference in-group B after conventional training [TA (p=0.001); LC (p<0.001); TI (p=0.005); PT (p<0.001); LA (p<0.001); HAASIS (p<0.001); and HAP (p<0.001)].

The analysis for the difference between two independent groups was conducted using a summary independent t-test on the postural angles of the TI, TA, PT, LC, LA, HAASIS, and HAP. The results showed both groups had significantly improved postural angles (p <0.05). There were no discernible variations between the groups' pre-treatment outcomes. However, a comparison of the two groups' findings after the treatment protocol was completed revealed significant improvements in favour of group A [TA (p=0.030); LC (p=0.007); TI (p=0.027); PT (p<0.001); LA (p=0.005); HAASIS (p=0.054); and HAP (p=0.017)] (Table 3).

DISCUSSION

This study examined how posture in children with CP was affected by pelvic control exercises. We discovered that pelvic control exercises significantly changed the postural angles. One of the most restricting conditions in the CP population is postural dysfunction. It limits abilities, which lowers participation in daily activities (23). Postural angles can be used to quantify this postural impairment. Exercises for pelvic control showed advantages in higher performance as indicated by postural angles. The pelvis, which is a part of the lower trunk, offers dynamic postural stability during anterior and lateral weight transfers, according to biomechanics. To perform lateral flexion and rotation of the trunk movements, a person need more dynamic stability of the lower trunk and pelvis (12).

Pre-treatment measurements of the postural angles from the two groups showed no significant changes and aberrant readings for these variables. According to Cook and Wollacot, this may be linked to neuromuscular abnormalities that obstruct the growth of appropriate postural control (24). We noticed changes in the angles of the TI, PT, LA, HAASIS, and HAP compared to children who are growing normally (7).

When standing, ambulant CP patients frequently have an anterior imbalance. Erroneous pelvic orientation and hip flexion contractures may also be connected to and contribute to the development of sagittal abnormalities because of anomalous pressures acting on the lumbar spine and pelvis that result in a relationship between TI and PT. Weak hip-extensors, abductors, and abdominal muscles may result in decreased hip extension and PT changes, which may in turn influence the link between LA and PT. Additionally, Suh SW et al. looked at the sagittal spinal alignment on radiographs of children with CP and found important connections between the sagittal spinopelvic properties (25).

The study group (A) that received pelvic control exercises saw a substantial improvement in postural angles after treatment. Angles of TA and LC increased while those of TI, PT, LA, HAASIS, and HAP decreased. We credit the pelvic control exercises, which encompassed pelvic motions in sagittal, coronal, and transverse planes, for this progress. In addition to helping a child establish a posture that promotes postural alignment, range of motion is crucial since pelvic movement is involved in numerous movement patterns, such as walking, sequencing actions, and balance. Decrease in anterior tilting of pelvis by pelvic control exercises like kicking football in front, taking step forward on a low height box improved the pelvic alignment which further increased the TA and LC. These exercises not only improved range of motion but also proximal dynamic pelvic stability, which may have improved intra-limb coordinated synergistic motions involving the hip, knee, and ankle joints. Additionally, it's possible that the selective contraction of the lower trunk and proximal hip muscles reduced the excessive co-contraction and stiffness of the involved lower limb muscles, potentially overcoming the stereotypical movement patterns (12) resulting in decrease of postural angles like PT, LA, HAASIS, HAP. The pelvic position impacts the alignment of the thoracic and cervical spines, which in turn affects the posture of the head and limbs and thus, decreasing TI. Therefore, additional postural angles can be adjusted by regulating the pelvis. Said et al.'s findings, which indicated that pelvic stability training can assist children with spastic CP improve their balance, validated the study group's notable increase in every measuring variable (26). This improvement was further supported by Sharma V et al.'s conclusion that proprioceptive neuromuscular facilitation (PNF), a type of pelvic training exercise, aids in enhancing pelvic control, which is crucial for preserving trunk control, gait, and balance (27).

Improvement has also been seen in the control group (B) where angles of TA and LC have increased while those of TI, PT, LA, HAASIS, and HAP have decreased in a similar pattern as seen in study group. These changes may have been brought about by the therapeutic exercise program's emphasis on a set of activities that help maintain a normal, upright posture. This is in line with the findings of Campbell et al., who found that the conservative methods of treatment for children with CP are centred on helping them meet sequential developmental goals and promoting normal movement patterns so they may learn useful activities (28). A general programme that emphasises postural alignment and movement quality includes particular targets for sitting, standing, and walking.

The two groups' post-treatment results showed a considerable improvement in favour of the study group (A) that had been given pelvic control exercises. This was supported by the findings of Dubey et al., 2018 who came to the conclusion that difficulty moving around and going about everyday activities is caused by improper muscle activation and inadequate movement control around the pelvis. They created an exercise regimen based on neurophysiological and biomechanical components of pelvic stability and discovered that pelvic stability training is advantageous in enhancing the control of the trunk and lower extremities movement, the strength of the hip muscles, the speed of gait, and daily activities in stroke patients (29). Additionally, Kim & Seo, 2015 claimed that the modified trunk-hip strengthening exercise was superior to the conventional exercise for improving trunk-hip activation and reducing anterior pelvic tilt motion when standing in children with spastic diplegia (30). These results align with those of Martín-Valero et al., 2018 who investigated the benefits of hippotherapy in children with spastic diplegic cerebral palsy and concluded that the three-dimensional reciprocal movement of the walking horse produced a rider's normalised pelvic movement, which was

similar to the pelvic movement of people without disabilities when they walk (31).

Following eight weeks of pelvic control training, an improvement in postural angles may be connected to improved motor control in the lower extremities and stronger hip muscles. The proximal dynamic pelvic stability is crucial to meet daily functional needs including transfers, walking on an even floor, and climbing stairs because the pelvis is the lower extremity's functional kinematics during standing and during mobility.

Limitations

Firstly, future studies are necessary to examine long-term impacts because a long-term follow-up assessment was not conducted. Second, muscle tone of children had been decreased after intervention but spasticity had not been included as outcome measure. Third, sophisticated techniques for assessing postural angles, such as 3-d motion analysis, were not applied. The fact that the study did not assess the strength of the pelvic muscles presents another potential flaw. Future research may show the real effects of pelvic control training using isokinetic strength testing or EMG analysis.

Conclusion

The results of this study indicate that incorporating pelvic control exercises into a conventional exercise regimen appears to be a popular way to help children with spastic CP improve their posture. For children with spastic diplegic CP, doctors and rehabilitation specialists may choose to incorporate selective pelvic control training into their multimodal treatment plan.

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APPENDIX

Pelvic Control Exercises for children with Spastic Diplegic Cerebral Palsy

Total duration: 8 weeks (thrice a week, each session: 30 minutes)

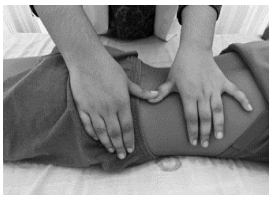
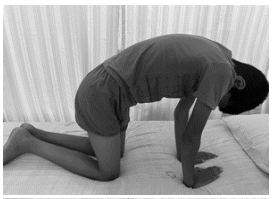
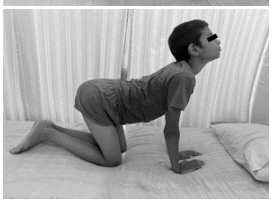
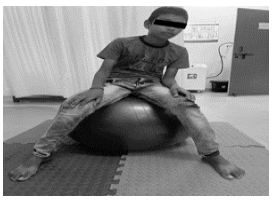
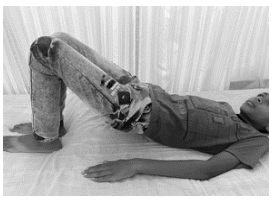
Total sessions: 24

Total phases: 4

Each phase is of 2 weeks duration

INITIAL PHASE (2 weeks)

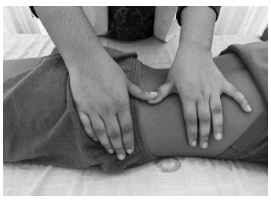
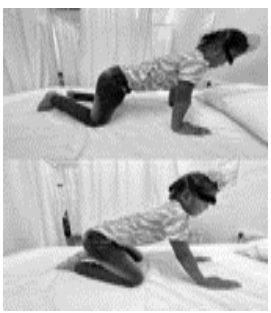
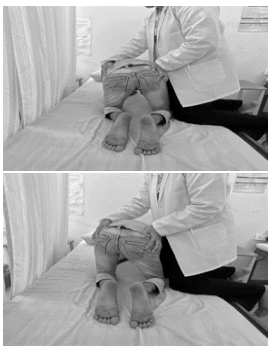
1. Pelvic Mobilisation	
Posterior rotation of the innominate	**5RepsX2sets**
Patient is in side-lying position with the bottom leg extended (to maintain a more neutral lumbar spine) and the top leg flexed. Starting posture for the therapist involves supporting the patient's bent leg while standing in front of their hips. One hand is put on the posterior surface of the ischial tuberosity, while the heel of the other is positioned over the anterior iliac spine. Using both arms at once, push the anterior iliac spine posteriorly and superiorly while pulling the ischial tuberosity down and forward to do the innominate's posterior rotation.	
Anterior rotation of the innominate	**5RepsX2sets**
Patient is in side-lying with the top leg slightly extended and the bottom leg flexed to 90 degrees (to make the lumbar spine more neutral). Starting posture for the therapist is to stand behind the patient and place one hand on the iliac crest and ASIS of the top leg while placing the heel of the other hand beneath the PSIS and buttocks of the same leg. Application of forces: Using both arms at once, push the PSIS superiorly and posteriorly while pulling the ASIS and iliac crest's anterolateral border forward and down to do the anterior rotation of the innominate.	
Central oscillatory P/A movement over the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 (base), S3 (middle), S5 (apex).	
Unilateral oscillatory P/A movement over the base of the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 level on each side.	
P/A movements to the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform Grade 3 P/A oscillations on each PSIS.	

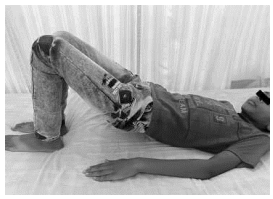
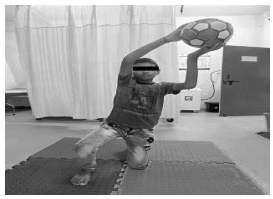
Lateral movement of the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the both thumbs perform Grade 3 lateral oscillatory translation on PSIS.	
2. Cat-camel exercise	**5RepsX2sets**
Place the patient in quadruped position. Ask the patient to slump his shoulders down towards the floor, arch his spine like a camel, tuck his tailbone in, and produce a cat-like curve with his spine.	 
3. Weight shifting on swiss ball	**5RepsX2sets**
Place the patient on the swiss ball in a supported sitting position. Gently rock the ball from side to side and forward to back while supporting their trunk or hips.	
4. Bridging	**5RepsX2sets**
Place the patient in supine position and ask him to bend his knees and raise his pelvis.	
5. Diagonal patterns in half kneeling	**5 left to right X2sets** **5 right to left X2sets**
Patient is in half kneeling position and do chopping patterns	
6. Posterior tilting exercises while kicking football in front	**5RepsX2sets**
The patient stands with his weight on his left leg and moves or kicks a football with his right foot. The only thing he does is kick the ball hard enough to maintain control of the right leg and stop it from pushing into the full extension pattern, whether it's towards a wall or someone else. The therapist facilitates the movement by tilting pelvis posteriorly.	

7. Posterior tilting exercises while taking step forward on a low height box	**5RepsX2sets**
The patient while standing, steps forward and places his one foot on the small step. He carefully places it on the stair without hurrying or slamming it while the therapist standing beside the patient tilt the patient's pelvis posteriorly.	
8. Pelvic stabilisation while maintaining hip-knee in 90-90 position	**5RepsX2sets**
The patient is in standing position. While supporting the patient's body with one arm, the therapist stands behind the patient and lifts his foot up while flexing his knee. With the aid of her hands, she supports his lower leg between her knees while allowing his thigh to fall towards the opposite knee while maintaining a level pelvis. She carefully lowers the foot to the floor once she senses that the injured leg is no longer pressing down into extension or pulling up with hip flexion. The patient tries to let his toes rest lightly on the ground behind him rather than forcing his foot downward.	 
9. Pelvic facilitation during stance phase	**5RepsX2sets**
The patient is in standing position. The therapist places her hands on each side of the patient's pelvis to tilt the pelvis up at the front by placing her thumbs or the ball of her palm over the gluteal muscles to encourage hip extension and prevent knee hyperextension.	

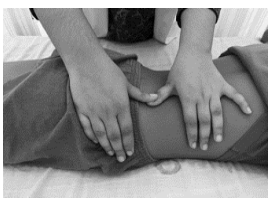
IMPROVEMENT PHASE (2 WEEKS)

1. Pelvic Mobilisation	
Posterior rotation of the innominate	**5RepsX2sets**
The patient is in side-lying position with the bottom leg extended (to maintain a more neutral lumbar spine) and the top leg flexed. Starting posture for the therapist involves supporting the patient's bent leg while standing in front of their hips. One hand is put on the posterior surface of the ischial tuberosity, while the heel of the other is positioned over the anterior iliac spine. Using both arms at once, push the anterior iliac spine posteriorly and superiorly while pulling the ischial tuberosity down and forward to do the innominate's posterior rotation.	
Anterior rotation of the innominate	**5RepsX2sets**
Starting posture for the patient is side-lying with the top leg slightly extended and the bottom leg flexed to 90 degrees (to make the lumbar spine more neutral). Starting posture for the therapist is to stand behind the patient and place one hand on the iliac crest and ASIS of the top leg while placing the heel of the other hand beneath the PSIS and buttocks of the same leg. Application of forces: Using both arms at once, push the PSIS superiorly and posteriorly while pulling the ASIS and iliac crest's anterolateral border forward and down to do the anterior rotation of the innominate.	

Central oscillatory P/A movement over the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 (base), S3 (middle), S5 (apex).	
Unilateral oscillatory P/A movement over the base of the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 level on each side.	
P/A movements can also be applied to the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations on each PSIS.	
Lateral movement of the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the both thumbs perform Grade 3 lateral oscillatory translation on PSIS.	
2. Quadruped Rocking	**5RepsX2sets**
The patient is in quadruped position. Ask the patient to place his hands directly under his shoulders, and his knees should be directly under his hips. Rock backward as far as he can without arching his lower back.	
3. Selective lateral movement of pelvis	**5RepsX2sets**
Patient is in quadruped position and his weight is evenly distributed between the hands and knees. The patient is asked to tilt his pelvis up while the therapist places her hands on either side of it, shortening that side of his trunk. She then facilitates the other side of his pelvis by switching the direction of her hands' motion.	

4. Bridging with hold	**5RepsX2sets**
Same as in bridging along with maintenance of position for 5 seconds	
5. Diagonal pattern with heavy object	**5 left to right X2sets** **5 right to left X2sets**
Patient is in half kneeling position and do chopping patterns while carrying heavy object in hands	
6. Lateral tilting of pelvis while kicking football sideways	**5RepsX2sets**
The patient is in standing position and moves or kicks a football sideways with his right foot while standing with his weight over the left leg. The only thing he does is kick the ball hard enough to maintain control of the right leg and stop it from pushing into the full extension pattern, whether it's towards a wall or someone else. The therapist facilitates the movement by tilting pelvis laterally.	
7. Anterior tilting of pelvis while taking step backwards on a low height box	**5RepsX2sets**
While standing, the patient steps backward and places his one foot on the small step. He carefully places it on the stair without hurrying or slamming it while the therapist standing beside the patient tilt the patient's pelvis anteriorly.	
8. Pelvic stabilisation while maintaining hip-knee in 90-90 position while carrying an object	**5RepsX2sets**
The patient stands with object in his hands. While supporting patient's body with one arm, the therapist stands behind the patient and lifts his foot up while flexing his knee. With the aid of her hands, she supports his lower leg between her knees while allowing his thigh to fall towards the opposite knee while maintaining a level pelvis. She carefully lowers the foot to the floor once she senses that the injured leg is no longer pressing down into extension or pulling up with hip flexion. The patient tries to let his toes rest lightly on the ground behind him rather than forcing his foot downward.	
9. Pelvic facilitation during swing phase	**5RepsX2sets**
The patient is in standing position and releases his hip and knee while allowing his heel to slide inward or in outward hip rotation in order to get ready to swing. The therapist applies pressure to the pelvis forward and downward along the femur's line as the hip and knee bend. She assists the pelvis rotate forward as the leg swings forward by preventing the patient from hitching up the side of it.	

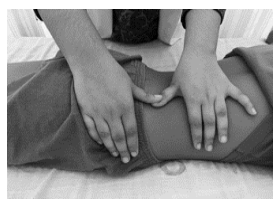
ADVANCE PHASE (2 WEEKS)

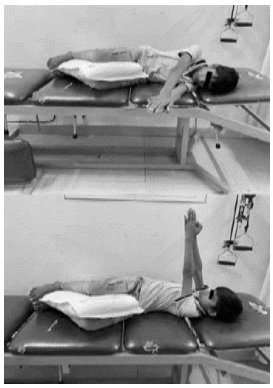
1. Pelvic Mobilisation	
Posterior rotation of the innominate	**5RepsX2sets**
The patient is in side-lying position with the bottom leg extended (to maintain a more neutral lumbar spine) and the top leg flexed. Starting posture for the therapist involves supporting the patient's bent leg while standing in front of their hips. One hand is put on the posterior surface of the ischial tuberosity, while the heel of the other is positioned over the anterior iliac spine. Using both arms at once, push the anterior iliac spine posteriorly and superiorly while pulling the ischial tuberosity down and forward to do the innominate's posterior rotation.	
Anterior rotation of the innominate	**5RepsX2sets**
The patient is in side-lying position with the top leg slightly extended and the bottom leg flexed to 90 degrees (to make the lumbar spine more neutral). Starting posture for the therapist is to stand behind the patient and place one hand on the iliac crest and ASIS of the top leg while placing the heel of the other hand beneath the PSIS and buttocks of the same leg. Application of forces: Using both arms at once, push the PSIS superiorly and posteriorly while pulling the ASIS and iliac crest's anterolateral border forward and down to do the anterior rotation of the innominate.	
Central oscillatory P/A movement over the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 (base), S3 (middle), S5 (apex).	
Unilateral oscillatory P/A movement over the base of the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 level on each side.	
P/A movements can also be applied to the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations on each PSIS.	
Lateral movement of the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the both thumbs perform grade 3 lateral oscillatory translation on PSIS.	

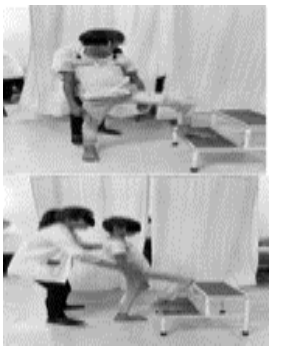
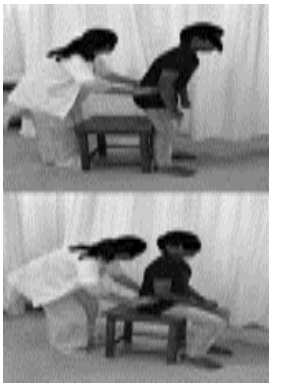
2. Isolated flexion-extension of pelvis in sitting	**5RepsX2sets**
The patient is in short sitting position and the therapist places one hand on the patient's lumbar spine while standing or sitting in front of him. She pulls his trunk forward until his hips are sufficiently flexed and it is vertically over his pelvis.	
3. Weight shifts in kneel standing	**5RepsX2sets**
The patient is in kneel standing position and shifts his weight from one leg to the other in turns. The therapist aids the pelvis' lateral mobility with her hands.	
4. Bridging with adductor squeeze	**5RepsX2sets**
Same as in bridging. Along with that, squeeze the thighs.	
5. Diagonal pattern Half kneeling with catch and throw ball	**5 left to right X2sets** **5 right to left X2sets**
In half kneeling position, patient does diagonal chopping patterns while catching and throwing ball	
6. Forward rotation of pelvis while kicking football crossing midline	**5RepsX2sets**
The patient is standing and moves or kicks a football with his right foot towards left foot while standing with his weight over the left leg. The only thing he does is kick the ball hard enough to maintain control of the right leg and stop it from pushing into the full extension pattern, whether it's towards a wall or someone else. The therapist facilitates the movement by forward rotating the pelvis.	

7. Lateral tilting of pelvis while taking step sideways on a low height box	**5RepsX2sets**
The patient is standing and steps sideways and places his one foot on the small step. He carefully places it on the stair without hurrying or slamming it while the therapist standing beside the patient tilt the patient's pelvis laterally.	
8. Pelvic stabilisation while maintaining hip-knee in 90-90 position with reach-outs	**5RepsX2sets**
The patient is standing while doing reach outs in front. While supporting patient's body with one arm, the therapist stands behind the patient and lifts his foot up while flexing his knee. With the aid of her hands, she supports his lower leg between her knees while allowing his thigh to fall towards the opposite knee while maintaining a level pelvis. She carefully lowers the foot to the floor once she senses that the injured leg is no longer pressing down into extension or pulling up with hip flexion. The patient tries to let his toes rest lightly on the ground behind him rather than forcing his foot downward.	 
9. Pelvic facilitation during stance phase on irregular surface	**5RepsX2sets**
Patient is standing on an irregular surface. The therapist positions her hands on each side of the pelvis for the patient who still needs help extending his hip in order to prevent knee hyperextension. She tilts the pelvis up at the front by placing her thumbs or the ball of her palm over the gluteal muscles to encourage hip extension.	
10. Pelvic facilitation during swing phase on irregular surface	**5RepsX2sets**
Patient is standing on an irregular surface. The patient releases his hip and knee while allowing his heel to slide inward or in outward hip rotation in order to get ready to swing. The therapist applies pressure to the pelvis forward and downward along the femur's line as the hip and knee bend. She assists the pelvis rotate forward as the leg swings forward by preventing the patient from hitching up the side of it.	

MAINTENANCE PHASE (2 WEEKS)

1. Pelvic Mobilisation	
Posterior rotation of the innominate	**5RepsX2sets**
The patient is in side-lying position with the bottom leg extended (to maintain a more neutral lumbar spine) and the top leg flexed. Starting posture for the therapist involves supporting the patient's bent leg while standing in front of their hips. One hand is put on the posterior surface of the ischial tuberosity, while the heel of the other is positioned over the anterior iliac spine. Using both arms at once, push the anterior iliac spine posteriorly and superiorly while pulling the ischial tuberosity down and forward to do the innominate's posterior rotation.	
Anterior rotation of the innominate	**5RepsX2sets**
The patient is in side-lying position with the top leg slightly extended and the bottom leg flexed to 90 degrees (to make the lumbar spine more neutral). Starting posture for the therapist is to stand behind the patient and place one hand on the iliac crest and ASIS of the top leg while placing the heel of the other hand beneath the PSIS and buttocks of the same leg. Application of forces: Using both arms at once, push the PSIS superiorly and posteriorly while pulling the ASIS and iliac crest's anterolateral border forward and down to do the anterior rotation of the innominate.	
Central oscillatory P/A movement over the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 (base), S3 (middle), S5 (apex).	
Unilateral oscillatory P/A movement over the base of the sacrum	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations at S1 level on each side.	
P/A movements can also be applied to the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the heel of hand perform grade 3 P/A oscillations on each PSIS.	
Lateral movement of the PSIS	**5RepsX2sets**
Patient lied in prone position, therapist by standing on the side with the both thumbs perform grade 3 lateral oscillatory translation on PSIS.	

2. Pelvic tilting with knees bent	**5RepsX2sets**
The patient is flexing both knees while standing with his feet apart. While keeping his upper body, shoulders, and head stationary, he rhythmically tilts his pelvis anteriorly and posteriorly. The therapist helps him through the exercise with her hands and several verbal cues until he succeeds. He bends his lumbar spine and she places her hand under his buttocks, tightening the gluteal group as if he were tucking in his tail. His lower abdominal muscles are helped to contract by her other hand. She gives him the impression that his lower abdominals are stretching and his buttocks are being raised at the rear when he is extending his lumbar spine	 
3. Weight shifts in standing	**5RepsX2sets**
The patient while standing rotates his body as if he were skiing, shifting his weight from one side to the other while standing up straight with his hips and knees slightly bent. His relaxed arms are at his sides. With her hands on either side of his pelvis, the therapist helps him move by maintaining his supporting hip forward while also facilitating his body's rotation.	
4. Bridging with one leg straight	**5RepsX2sets**
Same as in bridging. Along with that, patient keep his one leg straight.	
5. Rotate upper body away from lower body	**5RepsX2sets**
Ask the patient to twist their upper body and pelvis in the opposite directions while holding a block between their legs.	

6. Pelvic facilitation while kicking football in all directions	**5RepsX2sets**
The patient uses his foot to kick a football in various directions with enough force to maintain control of his leg and keep it from pushing into the full extension pattern, whether it is up against a wall or towards another person. The therapist facilitates the pelvic movement.	
7. Pelvic facilitation while taking step in all directions on different height of boxes	**5RepsX2sets**
The patient carefully places his foot on different height steps placed in different directions without hurrying or slamming the foot while the therapist standing beside the patient facilitate the pelvis accordingly.	
8. Pelvic stabilisation while maintaining hip-knee in 90-90 position with reach-outs in different directions	**5RepsX2sets**
The patient is in standing position. While supporting patient's body with one arm, the therapist stands behind the patient and lifts his foot up while flexing his knee. With the aid of her hands, she supports his lower leg between her knees while allowing his thigh to fall towards the opposite knee while maintaining a level pelvis. She carefully lowers the foot to the floor once she senses that the injured leg is no longer pressing down into extension or pulling up with hip flexion. The patient tries to let his toes rest lightly on the ground behind him rather than forcing his foot downward. While maintaining this position, patient do reach outs in different directions.	
9. Pelvic facilitation during sit to stand.	**5RepsX2sets**
The therapist facilitates the pelvis from posterior to anterior while patient do sit to stand.	

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Maria Alejandra ZAMBRANO PALENCIA, PT, MSc[1, 3]
Olga Lucia HINCAPIÉ GALLÓN, PT, MSc[1]
Jennifer RINCÓN PEÑA, PT, MSc[2,3]
Alejandro ARANGO ARENAS, PT, MSc[3]

1 *Faculty of health and rehabilitation, University Institution National Sports School, street 9 # 34-01, Cali, Colombia*
2 *Faculty of Physical Culture, Sports and Recreation, University Santo Tomas, street 18 #9-27, Bucaramanga, Colombia*
3 *Faculty of health, Autonomous University of Manizales, street 19a # 43a-50, Manizales, Colombia*

Correspondence (İletişim):

Olga Lucia Hincapié Gallón
Faculty of Health and Rehabilitation, University Institution National Sports School, street 9 # 34-01, Cali, Valle del Cauca, Colombia.olga.hincapie@endeporte.edu.co, ORCID: 0000-0003-0635-6510

Maria Alejandra ZAMBRANO PALENCIA
E-mail: mariaa.zambranop@autonoma.edu.co
ORCID: 0000-0003-3525-0416

Jennifer RINCÓN PEÑA
E-mail: jennifer.rincon01@ustabuca.edu.co
ORCID: 0000-0003-4996-9077

Alejandro ARANGO ARENAS
E-mail: alejandro.arangoa@autonoma.edu.co
ORCID: 0000-0002-4476-0867

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COMPARISON OF PHYSICAL FITNESS BETWEEN PARALYMPIC TENNIS PLAYERS WITH AND WITHOUT SPINAL CORD INJURY

ORIGINAL ARTICLE

ABSTRACT

Purpose: : This study aimed to compare grip strength, upper limb explosive strength, sprint, and agility in the wheelchair between Paralympic tennis players with and without spinal cord injury.

Methods: This study was designed as a cross-sectional study. The participants were 18 Colombian wheelchair tennis players from the open category who were divided into two groups according to the condition that generated the disability: spinal cord injury (n=9) and without spinal cord injury (n=9). Sociodemographic and sports data were collected, as well as results of manual dynamometry, medicine ball throws simulating forehand, backhand and serve gestures, 5-, 10- and 20-meter sprint, T-Test and Spider test.

Results: According to our findings, tennis players who had a spinal cord injury obtained shorter distances in throwing the medicine ball by simulating the forehand (p=0.008), backhand (p=0.009) and serve gestures (p=0.012) and took longer to execute the 5- (p=0.050), 10-meter sprint (p=0.040), T-Test (p=0.037) and Spider test (p= 0.025) in comparison with those without spinal cord injury.

Conclusion: The results of the present study demonstrated that athletes who have a spinal cord injury throw the medicine ball shorter distances, are less fast and agile with the wheelchair compared to athletes who have other types of conditions. Therefore, it is essential that individualized interventions are generated by the interdisciplinary team, with emphasis on explosive strength and aspects of mobility in the wheelchair, considering the type of condition that generated the disability, as well as possible adjustments to the functional classification system.

Keywords: Muscle Strength, Para-Athletes, Spinal Cord Injuries, Tennis

OMURİLİK YARALANMASI OLAN VE OLMAYAN PARALİMPİK TENİSÇİLERİN FİZİKSEL UYGUNLUKLARININ KARŞILAŞTIRILMASI

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışma, omurilik yaralanması olan ve olmayan Paralimpik tenis oyuncuları arasında tekerlekli sandalyede kavrama kuvveti, üst ekstremite patlayıcı kuvveti, sprint ve çevikliğin karşılaştırılmasını amaçladı.

Yöntem: Bu çalışma kesitsel bir çalışma olarak tasarlandı. Katılımcılar, açık kategoriden 18 Kolombiyalı tekerlekli sandalye tenisçisiydi ve sakatlığa neden olan duruma göre iki gruba ayrıldı: omurilik yaralanması (n=9) ve omurilik yaralanması olmayan (n=9). Sosyodemografik ve spor verilerinin yanı sıra manuel dinamometri, forehand, backhand ve servis hareketlerini simüle eden sağlık topu atışları, 5-, 10- ve 20 metre sprint, T-Testi ve Spider testi sonuçları toplandı.

Sonuçlar: Bulgularımıza göre, omurilik yaralanması geçiren tenisçiler, omurilik yaralanması geçirmeyenlere kıyasla, forehand (p=0,008), backhand (p=0,009) ve servis hareketlerini (p=0,012) simüle ederek tıp topu atmada daha kısa mesafe elde ettiler ve 5- (p=0,050), 10 metre sprint (p=0,040), T-Testi (p=0,037) ve Spider testi (p=0,025) gerçekleştirmeleri daha uzun sürdü.

Tartışma: Bu çalışmanın sonuçları, omurilik yaralanması olan sporcuların sağlık topunu daha kısa mesafelere fırlattıklarını, tekerlekli sandalyede diğer rahatsızlıklara sahip sporculara göre daha az hızlı ve çevik olduklarını göstermiştir. Bu nedenle, bireyselleştirilmiş müdahalelerin disiplinler arası bir ekip tarafından, patlayıcı kuvvet ve tekerlekli sandalyede hareketliliğin yönleri üzerinde durarak, engelliliği yaratan durumun türü ve fonksiyonel sınıflandırma sisteminde olası ayarlamalar göz önünde bulundurularak oluşturulması önemlidir.

Anahtar Kelimeler: Kas Kuvveti, Engelli Sporcular, Omurilik Yaralanmaları, Tenis.

INTRODUCTION

The evaluation of the Paralympic athlete is an issue that needs to be considered from different components: the first is the type of physical, visual or intellectual disability that the athlete has, the second corresponds to the sport and its characteristics, and the third is in relation to the eligible impairment that is linked to an underlying health condition among which is the spinal cord injury.

Following this order of ideas, a fundamental aspect in Paralympic sport is the functional classification, which seeks to group athletes with similar abilities to guarantee the fairest competition possible (1). Athletes who use a wheelchair have a great diversity of physical deficiencies and therefore there is a great variety of responses of physiological systems; coupled with the fact that the athlete and the wheelchair form a single unit where changes in either the subject or the chair will have an impact on overall sports performance (2).

According to the latest functional classification guidelines of the International Tennis Federation (ITF), wheelchair tennis (WT) has two sports categories: open (men's and women's) and Quad (mixed). Players are eligible to compete in the Open category if they have a permanent physical disability that compromises function in one or both lower extremities, while in the Quad category players are eligible if three limbs are compromised. This classification model, since it does not have a scoring system as in the case of other wheelchair sports such as basketball, handball, paddle tennis, among others, allows athletes with a wide variety of eligible physical deficiencies to compete in the open category.

In subjects with spinal cord injury, aerobic and anaerobic capacity and strength are inversely related to the level of injury and the integrity of the affected structures (3) among other aspects such as alterations in blood redistribution, the cardiac response and thermoregulation mechanisms (4–6). In contrast, the presence of physical deficiencies in the lower limbs, as is the case of people with lower limb amputation, presents a preserved trunk function that provides stability (7). On the other hand, athletes with injuries to the central nervous system such as cerebral palsy or stroke usually present increased muscle tone and an alteration in coordination that leads to imbalance and decreased muscle power (8).

In WT the movements are intermittent, multidirectional, and non-random, which challenges the player to change direction many times, with the need to accelerate between shots and decelerate before a shot. Although these aspects indicate that wheelchair mobility performance is a key performance factor (9), research is limited regarding the impact of the type of physical impairment that players have on their physical performance.

Some background information is the study by Sánchez-Pay and Sanz-Rivas (10) who evidenced in a sample consisted of 9 Spanish male high-level players, that WT players who had a spinal cord injury, in contrast to those who did not have a spinal cord injury, had lower values in all physical tests of strength, speed, agility and resistance. However, in that study a large number of statistically significant differences were not found, except in dynamometry of the dominant hand, 5-20-meters sprint, T-test and Hit and Turn resistance test. Previously Cavedon et al. (11) demonstrated that the severity of the impairment significantly affected the speed of the ball and the angle of the shoulder at the moment of impact of the ball, for which the authors suggested that the current classification overlooked the impact of disability on player performance, and therefore it was necessary to delve deeper into the topic and its future implications in the functional classification system.

In accordance with the previous approaches, it is necessary to recognize the specific needs of the sport in order to build solid foundations for the comprehensive approach to the athlete, considering that WT players with physical disabilities and with different eligible impairments criteria compete in the same category (Open). It was decided to carry out an investigation with the objective of comparing some aspects of physical fitness such as grip strength, explosive strength of upper limbs and mobility in the wheelchair between paralympic tennis players with and without spinal cord injury who compete in the open category.

METHODS

Study design and participants

This study was designed as a cross-sectional study. Totally 18 Colombian WT players selected to the I Paranational Pre-games 2023 tournament participated voluntarily. The study was conducted on December 7-10, 2022, at the District Racquet Park, Barranquilla, Colombia. Non-probabilistic convenience sampling was carried out, the sample consisted of 12 men (40.17 ± 11.13 years) and 6 women (25 ± 6.16 years), all classified in the open category. Participants were divided according to the type of condition that generated the disability into players with a spinal cord injury (SCI) (n=9) and players with other type of injuries (non-SCI) (n=9). The inclusion criteria were being duly registered for the tournament and having a minimum sporting experience of 6 months. Exclusion criteria included presenting an acute injury, general illness, or state of intoxication at the time of the evaluation. The sociodemographic and sports characteristics are presented in Table 1. All players agreed to participate voluntarily and signed the respective informed consent. This study was approved by the ethics committee of the Autonomous University of Manizales, Colombia (approval number: 143-141 of 11/09/2022) and was developed in compliance with the principles of the Declaration of Helsinki.

Instruments

Sociodemographic and sports data of the athletes were completed, such as age, sitting height, weight, sports experience, hours of weekly training and type of condition that generated the disability. Additionally, the results of 5 field tests were collected:

• **Dynamometry:** Dominant and non-dominant hand grip strength was measured with a Camry digital dynamometer (grip strength up to 200 lb/90 kg, 0.2 lb/100 g division). The test was carried out in the wheelchair sitting position with the arm extended and closed to the wheel, but without touching it (12).

• **Medicine ball throw:** The explosive strength of the upper limbs was evaluated through 3 tests of throwing a 2 kg medicine ball, simulating forehand, backhand and serve hits (12).

The participants stood behind the throwing line in a 45° position. A 10 m long measuring tape was placed on the court perpendicular to the throwing line and two evaluators marked the bounce zone of the recorded ball in 0.10 m sections:

a) Forehand/backhand: The ball was to be held with both hands on the throwing side (right or left), with the throwing hand providing the force, while the opposite hand was the guide. At the evaluator's signal, the player was to make an explosive movement and throw the ball with both hands as far as possible.

b) Service: The ball was to be held on the palm of the dominant hand to the side of the head. At the evaluator's signal, the player was to make an explosive movement and throw the ball simulating a shot put in athletics.

• **Sprint 20m:** Participants performed a 20-meter sprint holding the racket. To do this, the athlete was located 0.5 m from the starting line and, at the signal of the evaluator, completed the course in the shortest time possible. To record the total time for each section (0-5m, 0-10m, 0-20m), video recording was used with the MySprint app (MySp) (13). The methodology used by Ghigiarelli et al. (14) was adapted to guarantee the partial times of 0-5 m, 0-10 m, and 0-20 m by correcting the parallax of the video by placing 4 canes in adjusted positions (Figure 1).

• **T-Test:** A T-shaped circuit was marked out (Figure 2) which had to be completed as fast as possible. For this circuit, the player, seated in the wheelchair and holding the racket, was in the center of the court, behind the baseline, and at the signal of the evaluator he moved towards the intersections of the singles line with the service line, always passing through the central area of the court until returning to the starting area (12).

• **Spider Test:** The participant, sitting in the wheelchair and holding the racket, had to complete a circuit of maneuverability (Figure 3). The athlete was located behind the starting line, in front of the cone M located in the center of the baseline, and at the signal of the evaluator, the athlete went around the cone M, went to the right towards the cone A, went around it inside and went back again to go

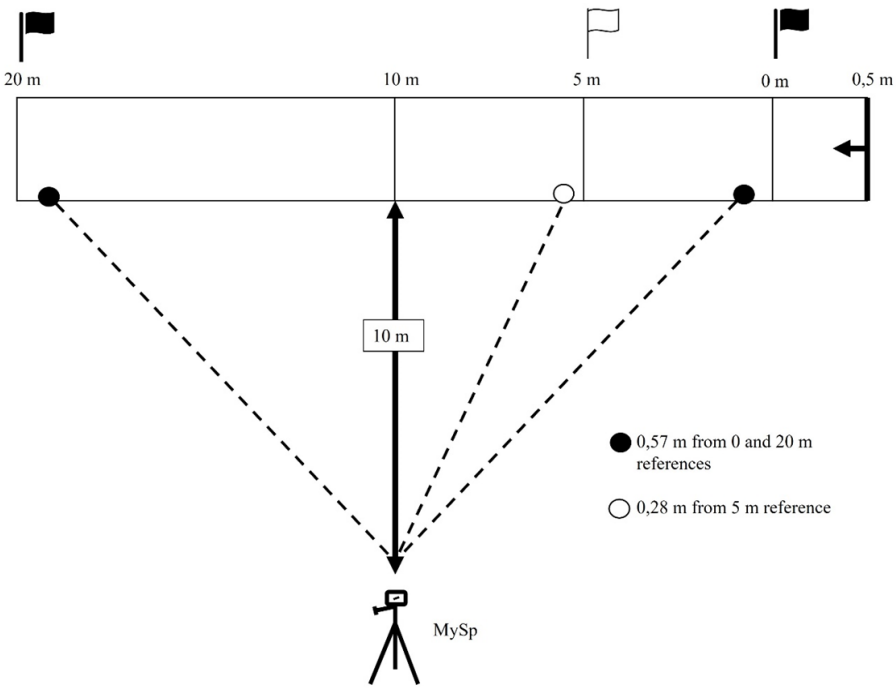

Figure 1. Reference scheme for placing poles in adjusted positions for recording the sprint with MySprint app.

around the cone M, then went to the cone B to go around it also inside and went again towards the cone M to go around it, this same route was done with cone C and D. The circuit was completed as fast as possible (15).

For each of the tests, three attempts were made with a rest time between each repetition of 2 min and the best value was recorded. For the wheelchair mobility tests, time was timed using the MySp.

Data collection was carried out in two sessions: the first was to complete the sociodemographic and sports characteristics questionnaire and the measurement of handgrip strength; and the second session for the remaining field tests. All tests

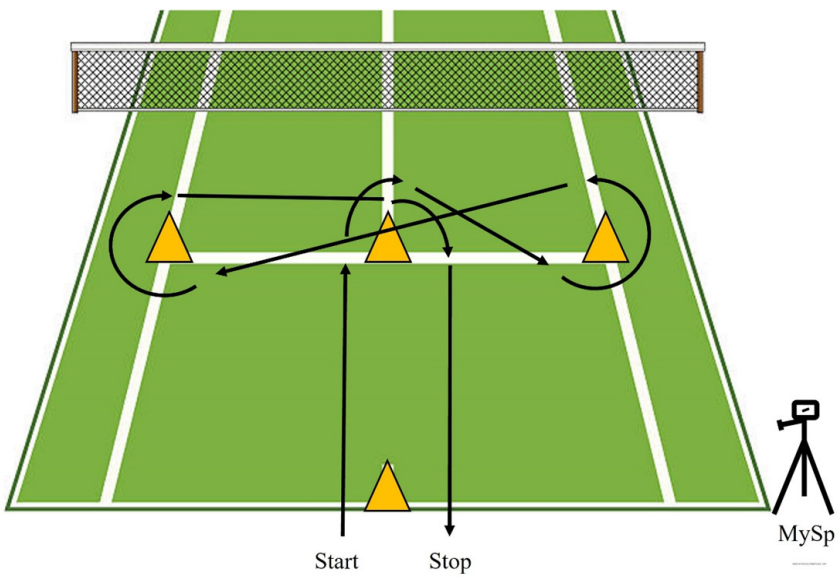

Figure 2. T-Test

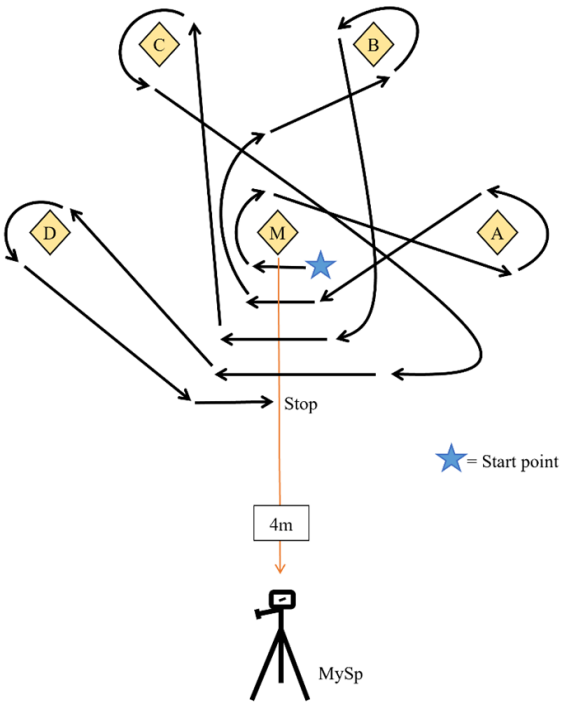

Figure 3. Spider Test (Distance AM = BM = CM = DM = AB = BC = CD = 1.2 m)

in the second session were performed outdoors on a hard surface tennis court with an ambient temperature between 28-30°C. Prior to the execution of the tests, the participants performed a 10-minute guided warm-up and carried out familiarization sessions with the purpose of reducing possible learning effects before recording the official marks for each test.

Statistical analysis

Data analysis was performed using IBM® SPSS® Statistics for Windows software (ver. 25.0; IBM Corp., NY, USA). A descriptive analysis was carried out presenting means ± standard deviation for the quantitative variables studied; and the sample was divided into two groups according to the type of condition that generated the disability. Due to the sample size, the Shapiro-Wilk and Levene tests were used to test the normality and homogeneity of variances for each variable. To make comparisons, the T test for independent samples and the Mann–Whitney U test were used for parametric and nonparametric variables, respectively. The $p < 0.05$ criterion was used for establishing statistical significance.

RESULTS

The sociodemographic and sports characteristics of the WT players are presented in Table 1.

According to the comparative analysis presented in Table 2, it was evident that players with non-SCI had better results in the dynamometry of the dominant hand (44.78 ± 8.83 vs 42.10 ± 12.38 kg) than players with SCI. But in the non-dominant hand SCI group was superior, however, none of these variables presented statistically significant differences. In terms of the explosive strength of the upper limbs, players with non-SCI threw the ball further in forehand (p= 0.008), backhand (p= 0.009) and serve throws (p= 0.012) compared to players with SCI, furthermore, in the sprint tests non-SCI group took less time to move at 5 m, 10 m and 20 m , with statistically significant differences in the distance from 0 to 5 m (1.79 ± 0.19 vs 2.13 ± 0.40 s, p =0.050) and from 0 to 10 m (3.26 ± 0.23 vs 3.86 ± 0.79 s, p=0.040). In relation to the agility tests, both in the T-test (p= 0.037) and in the Spider test (p= 0.025) the players with non-SCI took less time to execute compared to the SCI group, also with statistically significant differences.

Table 1. Sociodemographic and Sports Characteristics of the Study Participants

Variable	Sample (n=18)
Age (years)	35.11 ± 12.06
Sitting height (cm)	84.88 ± 4.75
Weight (Kg)	68.67 ± 19.42
Sports experience (years)	5.86 ± 5.01
Weekly training hours	11.83 ± 10.16
Type of Impairments (n (%))	
Spinal cord injury T3	1 (5.55)
Spinal cord injury T5-T6	3 (16.66)
Spinal cord injury T7-T8	1 (5.55)
Spinal cord injury T10-T12	1 (5.55)
Spinal cord injury T12-L1	2 (11.11)
Vertebral fracture T3-T6	1 (5.55)
Lower extremity poliomyelitis	2 (11.11)
Lower limb amputation	4 (22.22)
Polytrauma in lower limb	1 (5.55)
Lower extremity shortening	2 (11.11)

Data are expressed as mean ± standard deviation for continuous variables and 'n' were reported for categorical variables.

Table 2. Results of Physical Fitness Tests according to the Type of Condition that Generated the Disability.

Variable	SCI (n=9)	non-SCI (n=9)	p
Hand dynamometry			
Grip strength. Dom (Kg)	42.10 ± 12.38	44.78 ± 8.83	0.604
Grip strength. No Dom (kg)	41.62 ± 10.60	38.12 ± 9.77	0.477
Strength of upper limbs			
MBT forehand (cm)	3.78 ± 1.26	5.55 ± 1.23	0.008*
MBT backhand (cm)	3.52 ± 0.99	5.08 ±1.24	0.009*
MBT serve (cm)	4.41 ± 1.11	5.98 ± 1.25	0.012*
Sprint			
5 m (s)	2.13 ± 0.40	1.79 ± 0.19	0.050*
10 m (s)	3.86 ± 0.79	3.26 ± 0.23	0.040*
20 m (s)	7.02 ± 1.48	5.93 ± 0.44	0.077
Agility			
T-Test (s)	17.52 ± 2.76	15.18 ± 1.39	0.037*
Spider Test (s)	21.59 ± 2.70	19.04 ± 1.19	0.025*

Data are presented as mean± standard deviation. Dom: Dominant, No Dom: Non-dominant, MBT: medicine ball throw

DISCUSSION

The acknowledgement that tennis players with physical disabilities and with different eligibility criteria compete in the same category (open) has promoted research to build a functional classification system based on evidence as established by the International Paralympic Committee. In sports such as wheelchair basketball, studies have shown differences in general aspects of strength, aerobic and anaerobic capacity, agility, and speed in relation to the functional classification score (16,17)

and type of deficiency that players present (18,19), as well as studies in handball (20,21) and sports dance (22) that highlight differences in wheelchair mobility according to functional classification.

Although there is no specific scoring system in the WT, the open category brings together a wide variety of athletes with different types of disabilities. In this case, the only report found in WT players is Sánchez-Pay and Sanz-Rivas (10) who identified statistically significant differences in the dynamometry of the dominant hand with higher values in players with non-SCI, as reported in wheelchair basketball players (18,23). Although there are few reports in Paralympic sports that measure the grip strength of the non-dominant hand, our study shows that players with SCI have a relatively similar grip strength in both hands compared to those who do not have a spinal cord injury. Probably because the first group are permanent wheelchair users and bilaterally activate their upper limbs to carry out their activities of daily living. However, during sports activities the grip of the non-dominant hand on the wheel rim is crucial for braking and turning, and above all for being a support point that the athlete uses to obtain stability and safely perform the technical gestures of tennis with the opposite side.

On the other hand, the results of this research indicate that tennis players with limb deficiencies caused by lower limb amputations at different levels or differences in limb length due to different musculoskeletal disorders, throw the medicine ball farther with differences greater than a meter distance compared to those with a SCI, like what has been reported in Spanish WT (10). In this regard, Goosey-Tolfrey and Leicht (4) mention that deficiencies depending on the level of spinal cord injury will determine the ability of muscle groups to contribute to physical performance, as well as possible asymmetries in remaining upper extremity or trunk function that reduce bilateral force production. It is also recognized that athletes with a SCI who present an alteration in the control and stabilization of the trunk will have a limitation in generating power in the kinematic chain (24), as evidenced by Cavedon et al. (11) in a sample of 31 Italian wheelchair tennis players, finding that ball speed and shoulder angle during serve were greater in athletes who had an injury that did not alter trunk function compared to those who had SCI at different levels.

WT is identified by its intermittent dynamics with intervals of moderate/high intensity and repetitive actions of short duration (25,26). From an overview, the game is characterized by being shorter and faster (27–29) compared to conventional tennis, which indicates that the mobility performance of the wheelchair in speed and agility are relevant to respond to the demands of the game. The results of the sprint tests with racket in hand in partial times of 5, 10 and 20 meters, T-Test and spider test, indicate that players with non-SCI are faster and more agile with the wheelchair with differences greater than 2 seconds compared to the other group, similar to the research of Sánchez-Pay and Sanz-Rivas (10) who also found superior performance in WT players with non-SCI.

In relation to these findings, the systematic review by Altmann et al. (30) highlights that the strength of the trunk muscles has implications in the positioning of the trunk when in a seated position and in the application of effective force on the wheel rims, which significantly impacts the propulsion of the wheelchair. Therefore, it is necessary to consider the degree of trunk functionality in the functional classification processes in the WT since notable differences are observed in the performance of different components of physical fitness between athletes competing in the same category.

A limitation of the study is the integrated analysis of male and female athletes, which indicates that the findings should be interpreted with caution, always respecting the individuality of each athlete through an evaluation and intervention adjusted to their functional possibilities. Likewise, another factor to consider is that the data were collected at the end of the sports season, so the test results may reflect lower physical performance in the entire sample, however, it was possible to evaluate most of the national sports talent under the same space-time and methodological conditions.

In conclusion, it is recognized that the type of condition that generates the eligible deficiency within the framework of the functional classification, in this case, tennis players with and without SCI,

present significant differences in their physical performance; this invites the construction of individualized interventions by the interdisciplinary team, with emphasis on explosive strength and aspects of wheelchair mobility, considering the type of condition that generated the disability, as well as possible adjustments to the current functional classification system.

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Explanations: None

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PRIYA MEHTA, PT[1]
VARSHA RAHTORE, PT[2]
RAMHARI MEENA, PT[3]
SHIVAM DIXIT, M.Stat, MPhil[4]

1 *Demonstrator, MAHSI, MGM Medical College, (Department of Physiotherapy), Indore,(Madhya Pradesh), India.*
2 *MPT Neurology, MAHSI, MGM Medical College, (Department of Physiotherapy), Indore, (Madhya Pradesh), India.*
3 *Principal, MAHSI, MGM Medical College, (Department of Physiotherapy), Indore, (Madhya Pradesh), India.*
4 *MGM Medical College, (Department of Community Medicine), Indore, (Madhya Pradesh), India.*

Correspondence (İletişim):

PRIYA MEHTA
106-A, Shri Mangal Nagar, Bicholi Hapsi Road, Indore (Madhya Pradesh), 452010, India , Email: dr.priyamehta88@gmail.com, ORCID ID- 0009-0003-4722-8299

VARSHA RATHORE
E-mail: varsharathoremsv@gmail.comORCID ID: 0009-0008-4700-4638

RAMHARI MEENA
E-mail: dr.ramhariphysio@gmail.com
ORCID ID: 0000-0003-2758-5312

SHIVAM DIXIT
E-mail: dixit.shivam2007@gmail.com
ORCID ID: 0000-0002-6651-3381

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USE OF PHYSIOTHERAPY-RELATED SMARTPHONE APPLICATIONS IN CLINICAL PRACTICE AMONG PHYSIOTHERAPISTS IN INDIA – A CROSS SECTIONAL SURVEY STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: The rapid evolution of smartphone applications has transformed healthcare delivery worldwide. However, despite this growing trend, there is limited information on how Indian physiotherapists specifically utilize these mobile applications and their perspectives on integrating them into clinical practice.

Methods: This is a cross sectional descriptive survey study; the self-administered questionnaire was distributed to over 2,500 working physiotherapists across India through social media platforms. Questionnaire consists of 4 parts including demographics, knowledge, perceptions and barriers to adoption with current application functionalities. Data were obtained from 456 Physiotherapists. Descriptive data analysis was conducted which included calculating the frequencies and percentages of participants.

Results: Findings indicated that while 65.6% of respondents were aware of physiotherapy-related smartphone applications, only 35.1% reported using them in clinical practice. The majority of participants (79.5%) perceived these applications as beneficial. Key barriers included a lack of knowledge about appropriate applications (49.78%) and lack of technical support (40.35%). A statistically significant association was found between designation and use of physiotherapy-related smartphone applications at ($p < 0.05$).

Conclusion: This study reveals significant gap between awareness and practical integration of physiotherapy-related smartphone applications among Indian physiotherapists. Addressing identified barriers, including awareness, educational initiatives and technological support enhancements, could facilitate wider adoption of these applications in clinical settings.

Keywords: mHealth, Physiotherapy, Smartphone Applications.

HİNDİSTAN'DA FİZYOTERAPİSTLER ARASINDA KLİNİK UYGULAMADA "FİZYOTERAPİ İLE İLGİLİ" AKILLI TELEFON UYGULAMALARININ KULLANIMI – KESİTSEL BİR ANKET ÇALIŞMASI

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Akıllı telefon uygulamalarının hızlı evrimi, dünya çapında sağlık hizmetlerinin sunumunu dönüştürmüştür. Ancak, bu büyüyen trende rağmen, Hintli fizyoterapistlerin bu mobil uygulamaları nasıl kullandığı ve bunları klinik pratiğe entegre etme konusundaki bakış açıları hakkında sınırlı bilgi bulunmaktadır.

Yöntemler: Bu, kesitsel tanımlayıcı bir anket çalışmasıdır; kendiliğinden doldurulan anket, Hindistan genelindeki 2.500'den fazla çalışan fizyoterapiste sosyal medya platformları aracılığıyla dağıtılmıştır. Anket, demografik bilgiler, bilgi düzeyi, algılar ve mevcut uygulama işlevsellikleri ile ilgili benimseme engellerini içeren 4 bölümden oluşmaktadır. Veriler, 456 fizyoterapistten elde edilmiştir. Katılımcıların frekansları ve yüzdelerinin hesaplanmasını içeren tanımlayıcı veri analizi yapılmıştır.

Bulgular: Bulgular, katılımcıların %65.6'sının fizyoterapi ile ilgili akıllı telefon uygulamalarından haberdar olduğunu, ancak sadece %35.1'inin bunları klinik pratiğe uyguladığını göstermiştir. Katılımcıların büyük bir kısmı (%79.5), bu uygulamaları faydalı olarak algılamaktadır. Önemli engeller arasında uygun uygulamalar hakkında bilgi eksikliği (%49.78) ve teknik destek eksikliği (%40.35) yer almaktadır. Pozisyon ile fizyoterapiyle ilgili akıllı telefon uygulamalarının kullanımı arasında istatistiksel olarak anlamlı bir ilişki bulunmuştur ($p < 0.05$).

Sonuç: Bu çalışma, Hindistan'daki fizyoterapistler arasında fizyoterapi ile ilgili akıllı telefon uygulamalarına dair farkındalık ile bunların pratikte entegrasyonu arasında önemli bir boşluk olduğunu ortaya koymaktadır. Farkındalık, eğitim girişimleri ve teknolojik destek gibi belirlenen engellerin ele alınması, bu uygulamaların klinik ortamlarda daha geniş bir şekilde benimsenmesini kolaylaştırabilir.

Anahtar Kelimeler: mSağlık, Fizyoterapi, Akıllı Telefon Uygulamaları.

INTRODUCTION

The integration of smartphone applications has revolutionized healthcare delivery across various disciplines, including physiotherapy (1). Physiotherapists in India, like their counterparts worldwide, are increasingly incorporating these applications into their clinical workflows to enhance patient care and facilitate ongoing professional development (2,3). The way healthcare professionals use smartphones for accessing medical information shows transition to technology-driven solutions from relying on text-based resources (4).

Mobile health (mHealth) is a recent concept that involves using mobile and wireless technologies, like wearable, to deliver healthcare services. It encompasses a broad range of applications, from patient monitoring and disease management to health education and communication. Many physiotherapy applications fall under the broader category of mHealth, offering a high-reach and low-cost solution in both medicine and public health (5,6).

Telerehabilitation, which involves providing rehabilitation services from a distance, serves as an alternative to conventional treatment (7). Programs supervised remotely by healthcare professionals can help patients integrate exercise routines into their daily lives, extending beyond in-clinic rehabilitation. This approach may also address issues of non-compliance among physiotherapy patients (8).

In the realm of smartphones, 'applications ' refer to mobile applications developed to offer users various functionalities, such as web browsing, audio playback, video streaming, and content creation (9). Different app stores, like the Apple Store and Google Play Store, along with specialized websites, allow healthcare professionals to download applications tailored to their field, often for free or at a low cost (10,11).

Telerehabilitation and mHealth are revolutionizing physiotherapy care in India, leveraging the increasing penetration of smartphone technology. Telerehabilitation offers a much-needed solution to the shortage of qualified physiotherapists, particularly in rural and underserved areas, by enabling remote consultations via video conferencing. This allows therapists to guide patients through exercises, monitor their progress, and provide real-time feedback, overcoming geographical barriers and expanding access to quality care. This approach has proven effective for various conditions, offering a viable alternative to traditional in-person therapy, which can be challenging to access for many Indians (12,13). mHealth complements this by empowering patients with mobile apps for self-management. Apps like APECS, TeleHab, myPhysio App etc. track daily activity, offer personalized exercise plans, and provide educational resources in local languages, promoting patient engagement and adherence to treatment (14). This is particularly relevant in India, where patient education and self-management are crucial for long-term health outcomes.

These applications (apps) can be categorized into groups such as physiotherapy applications for patients, home rehabilitation exercise applications, assessment tools for physiotherapy, and educational resources related to Physiotherapy (15). In the current study, by Physiotherapy related Smartphone applications we mean applications used for Assessment, treatment planning and providing Physiotherapy treatment protocol to client. It does not include applications used for communication, for education and other fitness applications.

The mobile revolution offers a unique opportunity to provide medical help at any time and place it is needed (14,16). Despite the rapid adoption of smartphone applications in healthcare, there remains a significant gap in understanding their use and impact among physiotherapists in specific regions, such as India. While previous researches have explored the use of smartphone applications among Physiotherapy professionals in other countries like Nigeria (17), Kuwait (18), and South Africa (19), there is a lack of insight into their utilization and effect in India. Research conducted in India has mainly focused on physiotherapy students in Delhi, investigating their ownership of smartphones and use of apps for education and clinical development purpose (20). However, there is limited literature regarding the utility of physiotherapy-related smartphone applications for practicing professionals. This study aims to address the need to understand usage patterns, perceptions, and barriers to

adopting physiotherapy-related smartphone applications in clinical practice, highlighting the gap between technological awareness and its practical implementation.

METHODS

This cross sectional, descriptive design aimed to identify the use of Physiotherapy related smartphone application, their knowledge, perception and perceived barrier among Physiotherapists in India. A self-administered questionnaire was developed via Google Docs using available literature about use of mobile devices among health care providers (17,18,19, 20). The Google Doc consists of information about the survey study, consent, and the questionnaire. The questionnaire was then reviewed by five senior Physiotherapists for expert opinion on degree of relevance and degree of clarity of each question on a 4 point likert scale. Three minor changes were done as per experts feedback in the section of demographic and perception regarding Physiotherapy Applications. A pilot study was conducted on 30 working Physiotherapists to check suitability of the items on target population. Minor revisions were done to enhance clarity of questionnaire before distribution of final version. To assess the internal consistency of the questionnaire, Cronbach's alpha was calculated, yielding a value of 0.941, which indicated the excellent reliability of the instrument. The study applied Cochran's formula for sample size calculation, utilizing the proportion of individuals using physiotherapy-related smartphone applications, which was derived from a pilot study.

Cochran's formula

$$n = \frac{Z^2 * p * q}{d^2} = \frac{(1.96)^2 * 40 * 60}{(5)^2} = \frac{9216}{25} = 368.64$$

Take 10% non-response rate

$$368.64 + 36.86 = 405.50 \cong 410$$

Z^2= Critical value at 95% confidence level

p= Proportion of Use of Physiotherapy-Related Smartphone = 40% (based on pilot study)

q= 100-p= 100-40= 60%

d= margin of error (5%)

The questionnaire consists of 4 parts : Part A includes demographic data and work experience; Part B- explores the knowledge regarding physiotherapy related smartphone application; Parts C- deals with the perception about use of physiotherapy related smartphone application & Part D- explores with perceived barriers (app related as well as physiotherapist related) regarding use of smartphone application. The questionnaire consisted of a series of yes and no responses and multiple choice questions.

The study was approved by Ethics And Scientific Review Committee, MGM Medical College and MY Hospital ,Indore (M.P), India on 3rd November 2023 (REG No EC / MGM / NOV-23 /188) .After an ethical committee approval, the Self administered questionnaire was sent via social media platforms like LinkedIn, E-mail and WhatsApp groups to over 2500 working Physiotherapists all over India. The study involved participants with a minimum of one year of work experience, aged 21 or older, and of both genders. Physiotherapy students and individuals unable to read or understand English were excluded, as the survey was conducted in English only. Participants provided consent before accessing the digital survey. A reminder was sent after two weeks, with a final reminder issued four weeks later to complete the questionnaire.

Statistical analysis was performed using SPSS statistical software (New York 2017) version 25.0 (trial version). The results were presented using descriptive statistics, including percentages and frequency tables. Descriptive data analysis was performed, calculating the frequencies and percentages of participant's demographic information. Normality of the variables was checked by Shapiro- Wilk test. A cross-tabulation technique was employed to examine the associations between age, clinical experience, type of work, and the use of physiotherapy-related smartphone applications. Chi-square tests were conducted to determine the significance of these associations, at $p<0.05$. Additionally, Excel coding was utilized to calculate the frequencies of responses to multiple-choice questions related to perceptions and barriers.

Table 1. Demographic data of participants

Socio-demographic	Frequency	Percentage (%)
Gender		
Male	192	42.1
Female	264	57.9
Age		
<25	163	35.7
26-30	148	32.5
31-35	81	17.8
36-40	32	7.0
Above 40	32	7.0
Qualification		
Bachelor of Physiotherapy (BPT)	207	45.4
Master of Physiotherapy (MPT)	234	51.3
PhD	15	3.3
Clinical experience		
1-5	307	67.32
6-10	72	15.79
11-15	45	9.87
16-20	26	5.48
21-25	4	0.88
>25	3	0.66
Type of work		
Academic	95	20.83
Clinical	361	79.17
Location of your work		
Academic institute or university	95	20.8
Home care.	40	8.8
Hospitals	121	26.5
Private clinic	181	39.7
Trust / NGO organization	19	4.2

RESULTS

Demographics

A total of 456 participants completed the survey, yielding a response rate of 18.24%. Among the respondents, 58% were females and 42 % were males. Of the total respondents, 68.2% were in the age range of 21 and 35 years, while only 7% fell within the 36 to 40 age group. 51.3 % of the respondents were MPT and 45.4% had done their Bachelor's in Physiotherapy. 3.3 % respondents had done their Ph.D. Regarding clinical experience, 67.32% reported having 1-5 years of clinical experience, 25.66% have 6-15 years of experience, and only a small percentage had more than 15 years of experience (7.02%).Physiotherapists, who were not in academics, formed 79.17% of the total respondents. Table 1 represents the demographic characteristics of the participants.

Knowledge and use of Physiotherapy related Smartphone Applications.

All the participants own a smartphone. Of the respondents, 65.6% are aware of Physiotherapy related smartphone applications ; however only 45.2% had physiotherapy application in their smartphone and only 35.1% are using it in their clinical practice. A majority of participants (64.9%) did not use any smartphone applications in their clinical practice.

Table 2. Knowledge and use of physiotherapy related smartphone applications

Knowledge & use of Physiotherapy related smartphone applications	Frequency	Percentage (%)
Do you own smartphone		
iPhone	85	18.6
Android	371	81.4
Are you aware of Physiotherapy related smartphone applications		
Yes	299	65.6
No	157	34.4
Do you have Physiotherapy related applications in your smart phone		
Yes	206	45.2
No	250	54.8
Are you using any Physiotherapy related smartphone applications in your clinical practice		
Yes	160	35.1
No	296	64.9
How often do you use Physiotherapy related applications		
Never	296	64.9
Less than Twice weekly	18	3.94
More than twice weekly	15	3.33
Daily	19	4.16
When need arises	108	23.7

Among the 206 Physiotherapists who have applications on their smartphone, only 160 were using them in clinical practice. Table 2 represents participant's response for perception and use of Physiotherapy related smartphone applications .

Perception of Physiotherapy related Smartphone Applications.

Figure 1 presents a bar graph illustrating key perceptions about the use of physiotherapy-related smartphone applications in clinical practice. Among the respondents, 79.5% perceived physiotherapy-related smartphone applications as helpful in clinical practice. Most participants agreed that these applications: Provide solutions for accessibility issues (51.75%), save effort (43.66%), save time and money (47.37%) and internet has a potential role in healthcare (48.46%).

Barriers to using Smartphone Applications

A total of 296 participants (64.9%) reported not using any smartphone applications in their clinical practice. Barriers were categorized into two main groups: physiotherapist-related barriers and application-related barriers.

Physiotherapist-Related Barriers

A significant barrier was a lack of knowledge about appropriate applications, with 227 participants (49.78%) acknowledging this issue. Other barriers were: not aware of its availability (44.08%), because hands on is more beneficial and effective (40.13%), never explored (39.04%), lack of suitable training to practice tele rehabilitation (30.04%), lack of perceived clinical usefulness (29.6%), do not have time due to heavy patient care (22.37%) and reduces trust and confidence of patients (18.86%).

Figure 2 depicts the physiotherapist-related barriers to using smartphone applications.

Application-Related Barriers

The most frequently cited application-related barriers were lack of technical support (40.35%) and concerns about patient privacy and confidentiality (39.69%). High cost of applications (25.22%), limited or no mobile access (24.14%) and lack of personalized app to provide patient specific information and rehabilitation (2.85) are other barriers cited by participants. Figure 3 illustrates application related barriers in using smartphone applications.

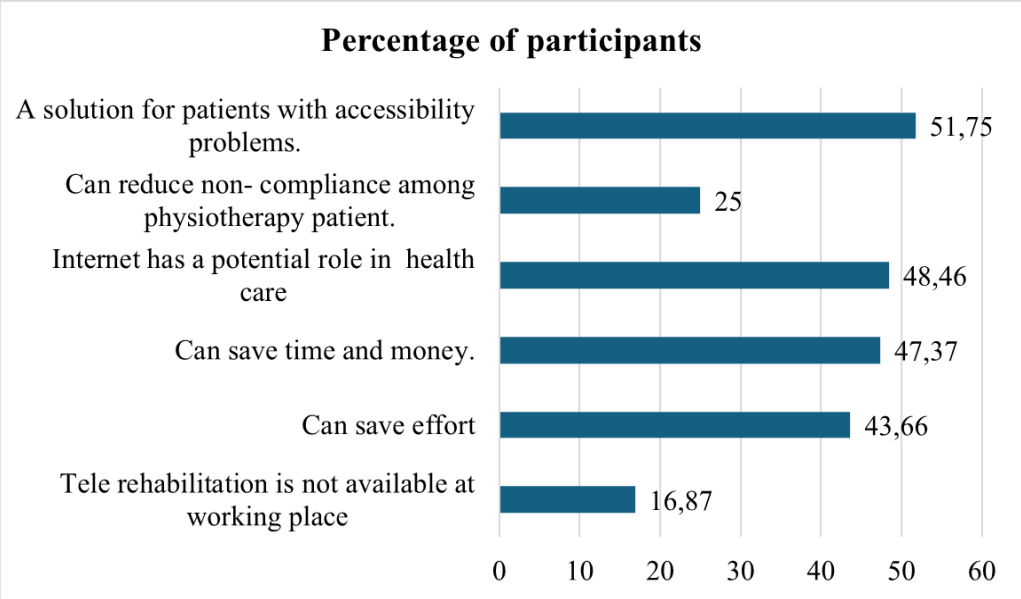

Figure1. Perception about use of smartphone applications.

Associations

Association between Age Group and Use of Physiotherapy-Related Smartphone Applications

Among the 160 participants who used smartphone applications, the majority were aged 21 to 35 years, with fewer users in the 35 to 40 years age group. However, there was no statistically significant association between age group and the use of physiotherapy-related smartphone applications (p= 1.000). Table 3 shows association between age and use of Physiotherapy related smartphone applications .

Association between Clinical Experience and Use of Physiotherapy-Related Smartphone Applications

The majority of participants using applications had 1 to 5 years of clinical experience, whereas those with 20-25 years of experience have the lowest percentage of users of these applications. Never-

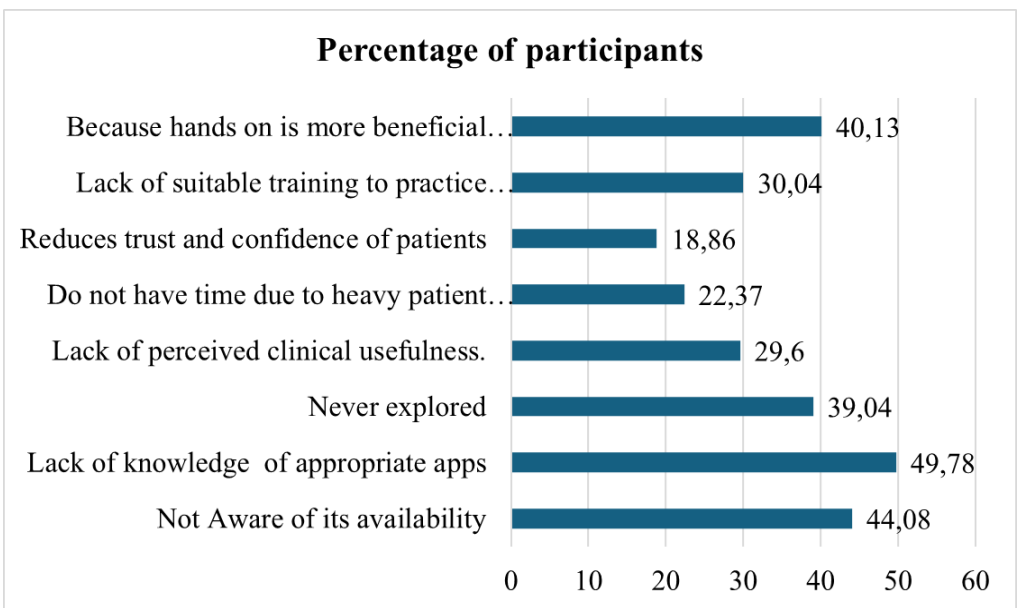

Figure 2. Physiotherapist related barriers in using smartphone applications

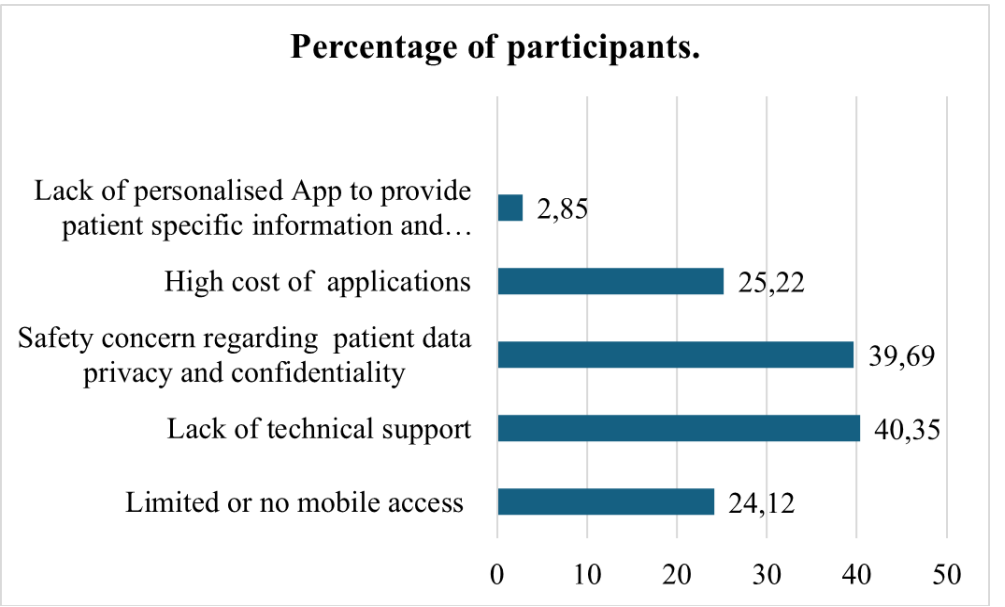

Figure 3. Applications related barriers in using smartphones applications

theless, there was no statistically significant association between clinical experience and the use of physiotherapy-related smartphone applications (p =0.530). Table 3 shows association between clinical experience and use of Physiotherapy related smartphone applications .

Association between Type of work and Use of Physiotherapy-Related Smartphone Applications

A significant association was observed between type of work and the use of physiotherapy-related smartphone applications. Specifically, 71% of clinical practitioners used these applications, whereas only 28% of professionals who were doing academic work used these applications. This indicates a statistically significant relationship between type of work and the use of physiotherapy-related smartphone applications. (p=0.002).Table 4 shows association between type of work and use of Physiotherapy related smartphone applications.

DISCUSSION

This study explored the use of physiotherapy-relat-

Table 3. Association between age and clinical experience with use of physiotherapy related smartphone applications.

Physiotherapy related applications in your smart phone	Age					Total
	<25	26-30	31-35	36-40	Above 40	
Yes	57 (35.6%)	52 (32.5%)	29 (18.1%)	11 (6.9%)	11 (6.9%)	160 (100.0%)
No	106 (35.8%)	96 (32.4%)	52 (17.6%)	21 (7.1%)	21 (7.1%)	296 (100.0%)
Chi-square value	**0.034**					
p-value	**1.000 (Not significant)**					
Physiotherapy related applications in your smart phone	**Clinical Experience (in Years)**					**Total**
	1-5	**11-15**	**16-20**	**21-25**	**6-10**	**More than 25**
Yes	103 (64.4%)	17 (10.6%)	11 (6.9%)	3 (1.9%)	25 (15.6%)	1 (0.6%)	160 (100.0%)
No	204 (68.9%)	28 (9.5%)	14 (4.7%)	1 (0.3%)	47 (15.9%)	2 (0.7%)	296 (100.0%)
Chi-square value	4.139					
p-value	0.530 (Not significant)					

Table 4. Association between type of work and use of physiotherapy related smartphone applications.

Physiotherapy related applications in your smart phone	Type of work		Total
	Academician	Clinical physiotherapist	
Yes	46 (28.7%)	114 (71.3%)	160 (100.0%)
No	49 (16.6%)	247 (83.4%)	296 (100.0%)
Chi-square value		9.366	
p-value		0.002 (Significant)	

ed smartphone applications among physiotherapists in India, providing insights into application usage, knowledge, perceptions, and barriers. Majority of Participants were in the age group of 21-35 years (68.2%) and had 1-5 years of clinical experience (67.32%). These findings support the study done in Nigeria where age group with the highest frequency was 21-30 years (47.9%) and had 1-5 years of clinical experience (58.3%). This shows a higher need of awareness, education and training among the age group of >35 years and experienced Physiotherapists in India. The findings reveal that 65.6% of respondents were aware of such applications, 45.2% had them installed on their smartphone and only, 35.1% reported using them in clinical practice. This result supports the findings of the study done in Nigeria on 48 Physiotherapists, which reported that 50% Physiotherapists were aware of applications while only 25% have Physiotherapy related smartphone applications related to health information in their smartphones (17). In contrast study done in India on Physiotherapy students in Delhi found that 62% of students have installed Physiotherapy related applications to support their education and practice activities, and 13.2% students who have installed apps but never used it (20). However they did not studied the barriers, practicing Physiotherapists face in adopting these apps in clinical practice, which is a crucial aspect investigated in our study. The difference in this result may be attributed to the fact that students may be more motivated to explore apps for learning and professional development, while practitioners face additional challenges like time constraints, patient privacy concerns, and pressure to prioritize traditional methods.

The study identifies a significant gap between the awareness (65.6%) and their actual use in clinical practice (35.1%). This suggests that although many physiotherapists are aware of these applications, they are not consistently integrating them into their day-to-day clinical work. Addressing this knowledge-to-action gap by providing regular training sessions or workshops and online courses on how to effectively integrate mobile applications into clinical practice, could lead to improved patient outcomes and more efficient clinical practice.

Despite the low usage rate, 79.5% of participants viewed these applications as helpful for clinical practice, with significant agreement that they provide solutions for accessibility issues (65%) and save time and money (60%). These findings are consistent with previous study, which reported that majority of Physiotherapists were willing to use telerehabilitation and considered it as a viable option to deliver healthcare to patients during COVID -19 pandemic in Kuwait (18). This positive perception reflects openness to integrating technology into health care settings among Indian Physiotherapists. Majority of the Indian population resides in rural areas with limited healthcare facilities. Rural tele-density has seen remarkable growth, increasing from just 1.9% in 2005 to over 48% by March 2015 as per a survey from Telecom Regulatory Authority of India (21). Awareness and training about Physiotherapy related smartphone applications to local healthcare workers and community health centers can provide solutions to lack of specialist and accessibility issues of the rural populations.

To improve integration of Physiotherapy related smartphone applications in to clinical practice, identification of barriers and steps to eliminate them is necessary. In this study, lack of knowledge of appropriate applications (49.78%), unaware of its availability (44.08%), because hands on is more beneficial and effective (40.13%), never explored (39.04%), lack of suitable training to practice tele rehabilitation (30.04%) were top Physiotherapist

related barriers to use of applications in Clinical Practice. These findings support the previous study done in India which found lack of awareness, lack of training & never explored as the major barriers, reported by Physiotherapy students (20). Our Study findings clearly suggest that many Physiotherapists may not be familiar with the apps available for assessment & rehabilitation, and this lack of knowledge directly impacts their ability to recommend these tools to patients. Increasing awareness through targeted training sessions, webinars, and workshops would help physiotherapists understand the benefits and practical applications of these tools. This can be done through collaborations with physiotherapy colleges and professional associations and by incorporating mobile technology utility into the undergraduate curriculum (9).

Finding of this current study also revealed that lack of technical support (40.35%), concern regarding patient privacy and safety (39.69%) and high cost of applications (25.22%) was major app related barrier for not using smartphone apps in clinical practice. These findings are in line with previous studies which have reported app quality, lack of personalised app, responsibility for client safety, lack of connection between technology experts and clinicians and lack of suitable training to practice telerehabilitation were the reasons for not prescribing apps (9,18,19). By addressing barriers like lack of technical support and privacy issue through technical assistance in hospitals and clinics and ensuring that apps comply with data protection regulations to prevent unauthorized access of patient information, can promote broader adoption of Physiotherapy related smartphone applications across India. Collaboration between Technology experts and Physiotherapists would help in designing of apps as per need will improve both the delivery and efficacy of therapy provided through telerehabilitation (20).

This study examined associations between demographic factors—specifically age and clinical experience—and the use of Physiotherapy related smartphone applications. Regarding age, while a higher proportion of users were observed in the younger age group (21-35 years), no statistical significant association was found between age and application usage. This suggests that older professionals can adopt smartphone applications once they become acquainted with their benefits and functionalities. Similarly, no statistical significant association was found between clinical experience and the use of smartphone applications, with majority of participants had 1-5 years of clinical experience. This suggests that experienced physiotherapists also see value in integrating mobile applications into practice. Additionally, statistically significant association was found between use of smartphone applications and type of work, highlights that clinical practitioners are more likely to incorporate smartphone applications compared to academic counterparts. This could be due to the more hands-on nature of clinical practice, where real-time access to information, treatment plans, or patient monitoring through mobile apps can improve workflow and patient outcomes. In contrast, academic professionals may have fewer opportunities to utilize mobile apps in their day-to-day responsibilities, which might explain their lower adoption rate. To best of our knowledge, there is no previous literature available to compare the results related to association of this study.

Our research has some limitations. First- the result could be strengthened by involving more Physiotherapists and increasing the sample size. Second -distribution of data was not uniform across India and use of social media platform for survey, may have introduced sampling bias.

The study found that Indian Physiotherapists have a positive perception for using apps, but there is a significant gap between awareness of these apps and actually using them in clinical practice. The research also identified key challenges, such as lack of knowledge about appropriate app and lack of technical support, as most important barrier to integration of smartphone apps in Physiotherapy. To overcome these obstacles, a structured training program is needed to enhance digital skills among Physiotherapists, with focus on practical use of these apps. Strengthening technical assistance through app tutorial, a help desk, and ensuring strong privacy protections are essential steps towards increasing the integration of smartphone applications into clinical practice in India. The implementation of these strategies involves collaboration among practitioners, educational

institutes, policy makers and technical experts to create a supportive system for digital innovation in Physiotherapy. Future research should explore ways to enhance digital literacy of physiotherapists, assessing reliability of available physiotherapy applications, evaluate the impact of smartphone applications on patient outcomes, and assess the effectiveness of different strategies for overcoming adoption barriers. By addressing these issues, the full potential of mobile health technologies can be realized, improving the efficiency and accessibility of Physiotherapy services in India.

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Explanations: None

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Abbreviations: (mHealth) – Mobile health, (Apps) – Applications

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Gizem Gül TURAN, PT, MSc [1]
Ayşe NUMANOĞLU AKBAŞ, PT, PhD [2]

TELEREHABİLİTASYON KABUL ÖLÇEĞİ HASTA FORMUNUN TÜRKÇE VERSİYONUNUN GEÇERLİK VE GÜVENİRLİĞİNİN İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Telerehabilitasyon Kabul Ölçeği Hasta Formunun (TRKÖ-H) Türkçe versiyonunun geçerlik ve güvenirliğini incelemek, hasta/bakım verenlerde telerehabilitasyon farkındalığını ve kabulünü değerlendirmek için bu çalışma planlandı.

Yöntem: Bu çalışmaya herhangi bir rehabilitasyon programında tedavi gören hasta veya bakım verenlerinden 18-65 yaş aralığında bulunanlar katıldı. TRKÖ-H Türkçeye çevrildikten sonra ölçek için açıklayıcı ve doğrulayıcı faktör analizi yapıldı. Ölçeğin iç tutarlılık ve test-tekrar-test güvenirliği hesaplandı. Katılımcıların telerehabilitasyon kabulü değerlendirildi.

Sonuçlar: Açıklayıcı faktör analizinde 12 maddelik ölçek için toplam varyansın %85,247'sini açıklayan 3 faktör elde edildi ve TRKÖ-H'den madde çıkarılmasına gerek olmadığı görüldü. Doğrulayıcı faktör analizi sonucunda Madde 10 modelden çıkarıldığında model uyumunun yeterli olduğu bulundu (RMSEA (root mean square error of approximation) =0,073, AGFI (Adjusted Goodness of Fit Index) =0,904, GFI (Goodness of Fit Index) =0,945, X2/df=2,448). Tüm maddelerin yüksek faktör yükleri vardı (>0,5). TRKÖ-H'nin iç tutarlılığı her üç faktör ve tüm maddeler için son derece yüksek değerlere sahipti (Cronbach Alpha=0,978-917). TRKÖ-H'nin mükemmel test-tekrar test güvenirliğine sahip olduğu görüldü (ICC: 0,998-0,985). Erkek katılımcıların, eğitim seviyesi yüksek olan katılımcıların ve daha genç katılımcıların telerehabilitasyon kabulü daha yüksekti (p<0,001).

Tartışma: Herhangi bir rehabilitasyon programında tedavi gören hasta veya bakım verenin telerehabilitasyon kabulünü ve farkındalığını değerlendirmek için TRKÖ-H geçerli ve güvenilir bir ölçektir. Eğitim düzeyi daha yüksek, genç, erkek hasta/bakım verenlerin telerehabilitasyon kabulü daha yüksektir. Bu özelliklerin dikkate alınması telerehabilitasyonun kabulünü ve başarısını arttırabilir.

Anahtar Kelimeler: Fizyoterapi ve Rehabilitasyon, Geçerlik, Güvenirlik, Hasta, Telerehabilitasyon

THE VALIDITY AND RELIABILITY STUDY OF THE TURKISH VERSION OF THE TELEREHABILITATION ACCEPTANCE SCALE PATIENT FORM

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study was planned to examine the validity and reliability of the Turkish version of the Telerehabilitation Acceptance Scale Patient/Caregiver Form (TRAS-P) and to evaluate telerehabilitation awareness and acceptance in patients/caregivers.

Methods: Patients or their caregivers between the ages of 18-65 who were receiving treatment in any rehabilitation program participated in this study. After the TRAS-P was translated into Turkish, exploratory and confirmatory factor analysis was performed for the scale. Internal consistency and test-retest reliability were calculated. Telerehabilitation acceptance of the participants are assessed.

Results: In the exploratory factor analysis, 3 factors explaining 85.247% of the total variance for the 12-item scale were obtained and it was seen that there was no need to remove any item from the TRAS-P. Confirmatory factor analysis revealed that the model fit was adequate when item 10 was removed from the model (RMSEA (root mean square error of approximation) =0,073, AGFI (Adjusted Goodness of Fit Index) =0,904, GFI (Goodness of Fit Index) =0,945, X2/df=2.448). All items had high factor loadings (>0.5). The internal consistency of the TRAS-P was extremely high for all three factors and all items (Cronbach Alpha=0.978-917). The TRAS-P had excellent test-retest reliability (ICC: 0.998-0.985). Male participants (p<0.001), participants with higher educational level (p<0.001), and younger participants (p<0.001) were more likely to accept telerehabilitation.

Conclusion: The TRAS-P is a valid and reliable scale to assess telerehabilitation acceptance and awareness of patients or caregivers who are being treated in any rehabilitation program. Patients/caregivers with higher levels of education, younger, male patients/caregivers are more likely to accept telerehabilitation. Taking these characteristics into account may increase the acceptance and success of telerehabilitation.

Key Words: Physiotherapy and Rehabilitation, Validity, Reliability, Patient, Telerehabilitation

1 Yozgat Bozok Üniversitesi, Sağlık Hizmetleri Meslek Yüksek Okulu, Yaşlı Bakımı Programı, Yozgat, Türkiye
2 Balıkesir Üniversitesi, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü, Balıkesir, Türkiye

Correspondence (İletişim):

Gizem Gül TURAN
Yozgat Bozok Üniversitesi, Sağlık Hizmetleri Meslek Yüksek Okulu, Yaşlı Bakımı Programı, Yozgat, Türkiye
gizemgulakkaya150@gmail.com, ORCID: 0000-0003-1356-7324

Ayşe NUMANOĞLU AKBAŞ
E-mail: aysenumanoglu@gmail.com
ORCID: 0000-0001-9296-8972

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GİRİŞ

İlk olarak 1993 yılında kullanılmaya başlanan Tele-tıp uzaktan klinik bakım sağlamak amacıyla elektronik iletişim kullanarak tıbbi bilgi alışverişi yapmaktır (1). Son on yılda, tele-tıbbın en çok kullanıldığı alanlardan biri, 2016 yılında önem kazanmaya başlayan ve telekomünikasyon teknolojilerini kullanarak rehabilitasyon uygulamalarını içeren telerehabilitasyondur (TR) (2)

Temel TR uygulamaları; telefon veya video konferans tabanlı değerlendirme, tedavi ve yönetim hizmetlerini içerirken, gelişmiş TR uygulamaları ise; canlı ses ve video, eş zamansız e-ziyaretler, sanal gerçeklik ve iki yönlü gerçek zamanlı etkileşim ziyaretleri gibi daha kompleks uygulamaları içerir (3, 4).

Günümüzde hızla gelişen teknoloji sayesinde TR kullanımı yaygınlaşmaktadır (5). TR hem akut hem de kronik dönemdeki nörolojik hastaların rehabilitasyonunu yönetmede (6), pediatrik rehabilitasyonda (7), geriatrik rehabilitasyonda (8), COVID-19'a bağlı gelişen çeşitli hastalıkların tedavisinde (9) kullanılmıştır. Ayrıca COVID-19 pandemisinden sonra TR kullanımının önemli ölçüde arttığı bilinmektedir. Pandemi sürecinde, sosyal mesafe önlemleri ve sağlık tesislerine sınırlı erişim sağlık hizmetlerinin uzaktan sunumunu teşvik etmiştir (10). Bu durum, rehabilitasyon hizmetlerinin de telekomünikasyon teknolojileri aracılığıyla sunulmasına olanak tanıyarak TR'nin yaygınlaşmasına neden olmuş ve hem hastalar hem de sağlık profesyonelleri için bu yöntem, tedavi süreçlerini güvenli ve erişilebilir hale getirmiştir (11). Pandemi sonrası dönemde de bu kullanımın devam ettiği ve TR'nin rehabilitasyon alanında kalıcı bir yer edindiği gözlemlenmektedir.

TR etkinliğinin değerlendirilmesi TR'nin gelecekte daha da yaygınlaşmasını sağlayacaktır. Literatürdeki TR uygulanan hastaların memnuniyet düzeylerinin incelendiği çalışmalara bakıldığında değerlendirmelerin yarı-yapılandırılmış görüşmeler, telefonda veya yüz yüze görüşme yoluyla uygulanan çalışmaya özgü anketler ile yapıldığı ve TR ile ilişkili olarak hastaların ve ailelerinin yüksek memnuniyet bildirdiği görülmektedir (12-15). Ülkemizde yapılan çalışmalarda TR'nin etkinliği genellikle yapılan müdahale ile ilişkili değerlendirme yöntemleri kullanılarak analiz edilmiştir (16-18). Türkiye'de yapılan bir çalışmada TR yoluyla egzersiz müdahalesinin hastalardaki memnuniyeti ölçülmek istenmiş fakat yazarlar literatürde hastaların TR beklenti ve memnuniyetlerini değerlendirebilecek standardize ölçek olmadığını belirtip hastaların TR beklenti ve memnuniyetlerini değerlendirmek amacıyla 5 sorudan oluşan Beklenti ve Memnuniyet Anketlerini hazırlamışlardır (19). Türkiye'de yapılan diğer bir çalışmada da egzersiz, manuel terapi ve TR destekli tedavinin hastadaki memnuniyetini değerlendirmek amacıyla yapılan müdahale ile ilişkili değerlendirme yöntemi olan Hasta Memnuniyet Anketi (PSQ-18) kullanılmıştır (20). Türkiye'de yapılan başka bir çalışmada TR uygulanan grupta TR'nin etkinliği telesağlık Kullanılabilirlik Anketi ve teletıp Memnuniyet Anketi uygulanarak değerlendirilmiş ve katılımcıların TR hizmetinden memnuniyet duydukları bildirilmiştir (21). TR etkinliğinin genellikle teletıp ve telesağlık memnuniyet anketleri veya yarı yapılandırılmış görüşmeler ile değerlendirildiği ve memnuniyet üzerinde odaklanıldığı görülmektedir. Bilgimiz dahilinde TR'ye özgü tasarlanmış, TR kabulünü değerlendiren Türkçe bir anket bulunmamaktadır. Bu çalışmanın amacı telerehabilitasyona özgü geliştirilmiş Telerehabilitasyon Kabul Ölçeğinin hastalar için geliştirilen versiyonunun Türkçe geçerlik ve güvenirliğinin incelenmesi ve ölçeğin literatüre kazandırılmasıdır. İkinci amacımız hastaların TR farkındalık düzeylerinin belirlenmesidir.

YÖNTEM

Katılımcılar ve Çalışma Prosedürü

Bu çalışma prospektif ve kesitsel araştırma olarak planlandı. Herhangi bir rehabilitasyon programında tedavi gören hastalar için geliştirilen Telerehabilitasyon Kabul Ölçeği Hasta Formu (TRKÖ-H) Türkçeye çevrilerek Türkçe versiyonunun geçerlik ve güvenirliği incelenmesi amaçlandı. Araştırmanın evrenini Malatya il sınırları içinde çalışmaya katılmak için dahil edilme kriterini sağlayan ve gönüllü olan katılımcılar oluşturdu. Veriler Kasım 2021- Haziran 2022 tarihleri arasında toplandı.

Ölçek geçerlik çalışmalarında örneklem büyüklüğünün belirlenmesi için ölçekteki madde sayısının 5-10 katı büyüklüğünde katılımcıya ulaşılması önerilmektedir (22). Ölçekte 12 madde yer almaktadır bu yüzden en az 120 katılımcı ile çalışmanın

tamamlanmasına karar verildi ancak daha fazla kişiye ulaşıldı ve 270 gönüllü katılımcının tamamı çalışmaya dâhil edildi. Re-test aşamasında TRKÖ-H ilk değerlendirmeden 15 gün sonra 70 katılımcıya tekrardan uygulandı.

Çalışmaya dahil edilme kriterleri; 18-65 yaş aralığında olmak, rehabilitasyon programı gören hasta/bakım veren olmak, hasta/bakım verenler için hazırlanmış Telerehabilitasyon Bilgi Broşürünü okumaktı. Çalışmaya katılmayı kabul etmeyen veya kabul ettiği halde anketleri eksik olarak tamamlayan bireyler çalışma dışı bırakıldı.

Bu çalışma Sivas Cumhuriyet Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu Başkanlığı tarafından 20.10.2021 tarihinde, 2021-10/01 sayılı etik kurulu kararıyla onaylandı. Katılımcıların yazılı onamları bilgilendirilmiş onam formu aracılığıyla alındı. Çalışma Helsinki Bildirgesi'ne uygun olarak yürütüldü.

TRKÖ-H'nin Türkçeye Çevrilmesi

Ölçeği geliştiren Dr. Abdullah Abdulrahman Almojaibel'den ölçeğin Türkçeye çevrilmesi amacıyla izin alındı. Ölçek geliştiricisinin oluşturduğu Telerehabilitasyon Bilgi Broşürü Türkçeye çevrildi. TRKÖ-H'nin Türkçe çevirisi önceki çalışmalarda belirlenen standart çeviri yöntemlerini takip ederek yapıldı (23) .

Türkçeye çevirisi yapılan ölçek, kabul edildikten sonra geçerlik ve güvenirlik çalışması yapılmaya başlandı. Ön uygulamada hasta/bakım verenler için TRKÖ-H 70 bireye uygulandı.

Verilerin toplanmasında Ön Değerlendirme Formu, Telerehabilitasyon Kabul Ölçeği ve Dijital Okuryazarlık Ölçeği kullanıldı.

Ön Değerlendirme Formu

Araştırmacı tarafından hazırlanmış olan ön değerlendirme formunda çalışmaya dahil edilen katılımcıların demografik bilgileri ve teknoloji kullanım durumlarıyla alakalı özellikleri kaydedildi.

Telerehabilitasyon Kabul Ölçeği Hasta Formu (TRKÖ-H)

TR kabulünün değerlendirilmesi amacıyla bu çalışma kapsamında Türk diline çevirisi yapılan TRKÖ-H kullanıldı. Telerehabilitasyon Kabul Ölçeği; TR kullanımının kabulü ile alakalı görüşleri belirlemeyi amaçlayan bir ölçektir (24). Bu ölçek Pulmoner TR kabulünü değerlendirmek amacıyla geliştirilen bir ölçektir. Fakat mevcut çalışmada farklı TR alanları da değerlendirilmek istendiği için; ölçek geliştiricisi Dr. Abdullah Abdulrahman Almojaibel ile görüşerek ölçekten pulmoner ifadesi çıkarıldı. Ölçeğin hastalar ve sağlık profesyonelleri için geliştirilen iki ayrı versiyonu vardır. Bu çalışmada hastaların TR kabulünü değerlendirmek için geliştirilmiş olan versiyon kullanıldı. TRKÖ-H'de algılanan faydalar ile ilgili 6 madde, algılanan kullanım kolaylığı ile ilgili 4 madde, kullanma niyeti ile alakalı 2 madde olmak üzere toplamda 12 madde yer almaktadır. Ayrıca 15 tane de hastanın kendisiyle alakalı demografik bilgilerini sorgulayan sorular mevcuttur. Ölçekte puanlama için Likert tipi 4'lü derecelendirme kullanılmaktadır (1=Kesinlikle Katılmıyorum, 2= Katılmıyorum, 3=Katılıyorum, 4= Kesinlikle Katılıyorum).

Dijital Okuryazarlık Ölçeği (DOÖ)

Dijital Okuryazarlık Ölçeği NG (25) tarafından geliştirilmiş olup Üstündağ ve diğ. (26) tarafından da Türkçeye uyarlanmıştır. Bu ölçme aracı tek faktörlü olmakla birlikte toplam 10 maddeden oluşmakta ve Likert tipi 5'li derecelendirme kullanılmaktadır (1=Kesinlikle katılmıyorum; 2=Katılmıyorum; 3=Kararsızım; 4=Katılıyorum; 5=Kesinlikle katılıyorum). Ölçekten alınan yüksek puanlar daha iyi bir dijital okuryazarlık seviyesini ifade etmektedir. Türkçe versiyonunun açıklayıcı faktör analizi sonuçlarına göre ölçek maddelerinin faktör yükleri 0.46 ile 0.74 arasındadır. Bu ölçekte tek faktörde 10 madde yer almakta ve toplam değişkenliğin %40'ını açıklamaktadır. Ölçeğin güvenirliğine ilişkin Cronbach Alpha değeri 0.86 olarak bulunmuştur (26).

İstatistiksel Analiz

Verileri analizinde IBM Statistical Package for Social Sciences (SPSS) 22.0 (SPSS Inc., Chicago, IL, USA) ve AMOS 24 (IBM Corp.2016, ABD) paket programları kullanıldı. Sayısal değişkenlerin normal dağılıma uygunluğu Kolmogorov Smirnov testi, ortalama ve medyanın birbirine yakınlığı, çarpıklık ve basıklık açısından incelendi. Sayısal değişkenler ortalama, standart sapma veya ortanca, minimum, maksimum, kategorik değişkenler sayı ve yüzde olarak sunuldu.

Açıklayıcı faktör analizi ve doğrulayıcı faktör analizi

ölçeğin yapı geçerliği için yapıldı. Açıklayıcı faktör analizi yapılmadan önce ölçekteki maddelerin ölçek toplam puanına göre ilişkisini görmek için korelasyona dayalı madde analizi yapıldı. Bu analizde ölçeğin madde-toplam ölçek korelasyonları incelendi; bu korelasyonlarda 0,30'un altında değere sahip olan maddeler çıkarılması önerilmektedir (27).

Maddelerin faktör dağılımını belirlemek amacıyla açıklayıcı faktör analizi yapıldı (28). Örneklem büyüklüğünün faktör analizi için yeterliliğini araştırmak için Kaiser-Meyer-Olkin (KMO) katsayısı ve Bartlett küresellik testi ile incelendi. Veri setinin faktör analizine uygunluğu için KMO değeri en az 0,80-0,90 arasında olması gerekir (28, 29). Bartlett küresellik testi sonucunda Kikare (x2) için p değerinin 0,05'ten küçük olması gerektiği belirtilmiştir (29).

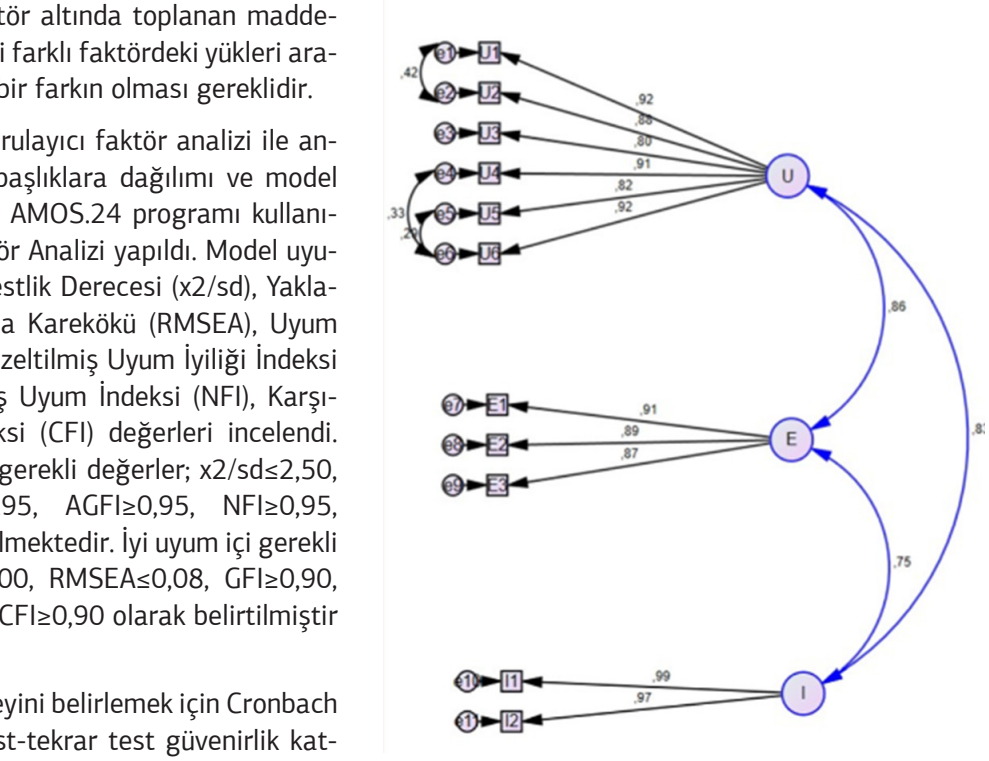
Açıklayıcı faktör analizinde belirlenen her faktörün öz değerinin en az 1 olması ve açıklanan varyans oranının tüm anket için %32'nin üzerinde olması önerilmektedir (29). Çalışmamızda açıklayıcı faktör analizi bunlar doğrultusunda yorumlandı. Varimax rotasyon tekniği ile ölçekte hangi maddelerin hangi faktöre yüklediği belirlendi (30). Varimax rotasyon tekniği ile yapılan analizde her bir madde için madde yüklerinin en az 0,40'ın üstünde olması, aynı anda birden fazla faktör altında toplanan maddelerde aynı maddenin iki farklı faktördeki yükleri arasında 0,10'in üstünde bir farkın olması gereklidir.

Yapı geçerliği için doğrulayıcı faktör analizi ile anket maddelerinin alt başlıklara dağılımı ve model uyumu değerlendirildi. AMOS.24 programı kullanılarak Doğrulayıcı Faktör Analizi yapıldı. Model uyumu için, Ki Kare/Serbestlik Derecesi (x2/sd), Yaklaşık Hataların Ortalama Karekökü (RMSEA), Uyum İyiliği İndeksi (GFI), Düzeltilmiş Uyum İyiliği İndeksi (AGFI), Normlaştırılmış Uyum İndeksi (NFI), Karşılaştırmalı Uyum İndeksi (CFI) değerleri incelendi. Mükemmel uyum için gerekli değerler; x2/sd≤2,50, RMSEA≤0,05, GFI≥0,95, AGFI≥0,95, NFI≥0,95, CFI>0,95 olarak belirtilmektedir. İyi uyum içi gerekli değerler ise x2/sd≤5,00, RMSEA≤0,08, GFI≥0,90, AGFI≥0,85, NFI≥0,90, CFI≥0,90 olarak belirtilmiştir (31).

Anketin güvenirlik düzeyini belirlemek için Cronbach alfa iç-tutarlılık ve test-tekrar test güvenirlik katsayıları hesaplandı. Cronbach Alpha katsayısı α<0,5 kabul edilemez, 0,5≤α<0,6 zayıf, 0,6≤α<0,7 kabul edilebilir, 0,7≤α<0,9 iyi, α ≥0,9 mükemmel şeklinde yorumlanarak sınıflandırılmaktadır (32). Test tekrar-test güvenirliği Sınıf İçi Korelasyon Katsayısına (ICC) göre belirlendi. ICC'nin kabul edilebilir değerleri <0,70 uyumsuz, 0,70-0,84 kabul edilebilir, 0,84-0,94 yüksek, 0,94-1 mükemmel şeklinde yorumlanarak sınıflandırılır (33). Ölçüt bağımlı geçerlik için TRKÖ-H'nin DOÖ ile ilişkisi Pearson Korelasyon Analizi ile incelendi. Korelasyon Analizden elde edilen "r" değerleri şu şekilde yorumlandı; 0,00-0,30 ihmal edilebilir, 0,30-0,50 düşük, 0,50-0,69 orta, 0,70-0,89 yüksek ve 0,90-1,00 çok yüksek ilişki (34). İstatistiksel anlamlılık derecesi p<0,05 olarak belirlenmiştir.

SONUÇLAR

Çalışmaya 18-65 yaş arası, yaş ortalaması 40,63±12,11 olan 182 kadın (%67,41) ve 88 erkek (%32,59) olmak üzere toplamda 270 hasta/bakım veren katıldı. Çalışmaya katılan kişilerin dağılımına bakıldığında 211 kişinin (%78,15) rehabilitasyon hizmetinden yararlanan hasta, 59 kişinin (%21,85) hastanın temel bakım vereni olduğu saptandı. Katılımcıların tanı gruplarına göre dağılımlarına bakıldığında büyük çoğunluğunu 128 kişiyle (%47,41) ortopedik hastalık grubunun oluşturduğu görüldü.



Şekil 1. TRKÖ-H için Doğrulayıcı Faktör Analizi

En az sayıda katılımcı Kardiyo-pulmoner hastalık grubunda (n=5, %1,85) yer almaktaydı (Tablo 1).

TRKÖ-H İçin Korelasyona Dayalı Madde Güvenirlik Analizi

TRKÖ-H İçin Korelasyona Dayalı Madde Güvenirlik Analizi sonuçlarına göre bir maddenin diğer maddelerle olan ilişkisi (Madde Ölçek Toplam Korelasyonu) tüm maddeler için 0,30'un üstünde olduğundan korelasyona dayalı madde analizi göre ölçekten madde çıkarılmasına gerek olmadığı sonucuna varıldı (Tablo 2).

TRKÖ-H İçin Açıklayıcı Faktör Analizi

Örneklem büyüklüğünün faktör analizi için yeterliliğini araştırmak amacıyla yapılan KMO değerinin

Tablo 1. Hasta/Bakım Verenlerin Demografik Bilgileri (n=270)

Özellikler	**(N=270)**	**n (%)**
Cinsiyet	**Sayı (n)**	**Yüzde (%)**
Kadın	182	67,41
Erkek	88	32,59
Yaş	**Sayı (n)**	**Yüzde (%)**
30 yaş altı	61	22,59
30 yaş-49 yaş	138	51,11
50 yaş ve üzeri	71	26,30
Aile Tipi	**Sayı (n)**	**Yüzde (%)**
Çekirdek Aile	237	87,78
Geniş Aile	33	12,22
Öğrenim Durumunuz	**Sayı (n)**	**Yüzde (%)**
İlk ve orta öğretimden mezun	87	32,22
Lise mezunu	67	24,8
Ön lisans, lisans ve lisansüstü eğitimden mezun	116	43,0
Yaşanılan Yer	**Sayı (n)**	**Yüzde (%)**
Kırsal	22	8,56
Kentsel	235	91,44
Gelir Durumu	**Sayı (n)**	**Yüzde (%)**
10.000 TL ve altı	166	61,48
10.000 TL ve üzeri	32	11,85
Belirtmek istemeyen	72	26,67
Yaşanılan Yer	**Sayı (n)**	**Yüzde (%)**
Kırsal	211	78,15
Kentsel	59	21,85
Tanı Grupları	**Sayı (n)**	**Yüzde (%)**
Nörolojik Rehabilitasyon	81	30,00
Pediatrik Rehabilitasyon	56	20,74
Ortopedik Rehabilitasyon	128	47,41
Kardiyo-Pulmoner Rehabilitasyon	5	1,85
Rehabilitasyon Hizmetinin Türü	**Sayı (n)**	**Yüzde (%)**
Hastanede (devlet ya da özel) ayaktan tedavi programı	116	42,96
Hastanede (devlet ya da özel) yatan hasta programı	7	2,59
Özel eğitim ve rehabilitasyon merkezi	62	22,96
Diğer	85	31,48
	Ortalama±Standart Sapma	**(Minimum-Maksimum)**
Günlük Akıllı Telefon Kullanım Süresi (saat)	4,31±4,00	0-15
Günlük İnternet Kullanım Süresi (saat)	3,78±3,00	0-12

Tablo 2. TRKÖ-H İçin Korelasyona Bağlı Madde Analizi Sonuçları ve TRKÖ-H Faktör Yüklerinin Dağılımı (n=270)

Ölçek Maddeleri	Madde Çıkarıldığında Ölçek *X*	Madde Çıkarıldığında Ölçek Varyansı	Madde Ölçek Toplam Korelasyonu	Madde Çıkarıldığında Ölçek Cronbach Alfa Değeri
Madde 1	29,4556	55,357	0,894	0,964
Madde 2	29,4741	55,968	0,867	0,964
Madde 3	29,2296	57,018	0,765	0,967
Madde 4	29,4185	55,523	0,879	0,964
Madde 5	29,4481	56,613	0,798	0,966
Madde 6	29,4333	55,421	0,907	0,963
Madde 7	29,4185	56,527	0,804	0,966
Madde 8	29,4370	56,961	0,758	0,967
Madde 9	29,3481	56,332	0,827	0,966
Madde 10	29,6370	55,057	0,816	0,966
Madde 11	29,6296	56,606	0,852	0,965
Madde 12	29,6185	56,534	0,834	0,965
			Cronbach Alpha: 0,968	

	Döndürülmüş Faktör Matrisi		
	Faktörler		
	Faktör 1	**Faktör 2**	**Faktör 3**
Madde 1	0,743		
Madde 2	0,800		
Madde 3	0,758		
Madde 4	0,835		
Madde 5	0,917		
Madde 6	0,827		
Madde 7			0,844
Madde 8			0,989
Madde 9			0,615
Madde 10		0,704	
Madde 11		0,912	
Madde 12		0,955	
Öz Değerler	8,926	0,728	0,575
Açıklanan Varyans	74,383	6,070	4,794
Toplam Varyans	74,383	80,453	85,247

Faktör 1: Algılanan Fayda, Faktör 2: AlgılananKullanım Kolaylığı, Faktör 3: Kullanma Niyeti

0,933, Bartlett Küresellik Testi değerinin anlamlı (x2=4019,845, p<0.001) bulundu. On iki maddelik ölçme aracı için toplam varyansın %85,247'sini açıklayan 3 faktör elde edildi. Açıklayıcı faktör analizi ile TRKÖ-H'den madde çıkarılmasına gerek olmadığı görüldü. TRKÖ-H'nin faktör dağılımlarına baktığımızda faktör 1'de madde 1-6, faktör 2'de madde 7-9, faktör 3'te madde 11,12 yer aldığı belirlendi (Tablo 2).

TRKÖ-H İçin Doğrulayıcı Faktör Analizi

TRKÖ-H için yapılan doğrulayıcı faktör analizi sonucunda regresyon katsayısı düşük olan Madde 10'un modelden çıkarıldığında model uyum indeksleri kabul edilebilir bulundu. (RMSEA=0,073, AGFI=0,904, GFI=0,945, X2/df=2,448). Tüm maddelerin yüksek faktör yükleri vardı. Yapılan analizlerden sonra ölçek 11 maddeye indirgendi; madde 1-6 Telerehabilitasyonun Algılanan Faydası boyutunda, madde 7-9 Telerehabilitasyonun Algılanan Kullanım Kolay-

Tablo 3. TRKÖ-H ile DOÖ Arasındaki İlişki (n=270)

		Dijital Okur Yazarlık Ölçeği Toplam Puan
TRKÖ-H Algılanan Faydası	**r**	**0,427**
	p	**<0,001****
TRKÖ-H Algılanan Kullanım Kolaylığı	**r**	**0,535**
	p	**<0,001****
TRKÖ-H Kullanma Niyeti	**r**	**0,448**
	p	**<0,001****
TRKÖ-H Toplam Puan	**r**	**0,493**
	p	**<0,001****

r; Pearson korelasyon analizi, *p<0,05, **p<0,01.

Tablo 4. TRKÖ-H İçin İç Tutarlık Değerleri (n=270), Test-Tekrar Test Güvenirliği (n=270)

	İç Tutarlık Değerleri (n=270)				Test-Tekrar Test Güvenirliği (n=270)	
TRKÖ-H Boyutları	**Cronbach Alpha**	**Mc Donald's Omega**	**Madde Sayısı**	**Ölçek Maddeleri**	**ICC**	**95% Güven Aralığı Alt Sınır-Üst Sınır**
Algılanan Faydası	0,955	0,956	6	1-6	0,998	0,997-0,999
Algılanan Kullanım Kolaylığı	0,917	0,918	3	7-9	0,985	0,975-0,991
Kullanma Niyeti	0,978		2	11,12	0,991	0,984-0,994
Tüm maddeleri	0,966	0,966	11	1-6, 7-9, 11,12	0,997	0,994-0,998

ICC: Sınıf İçi Korelasyon Katsayısı

lığı boyutunda, madde 11,12 ise Gelecekte Telerehabilitasyon Kullanma Niyeti boyutunda yer almaktaydı (Şekil 1).

TRKÖ-H'nin Ölçüt Bağımlı Güvenirliği

TRKÖ-H'nin DOÖ ile ölçüt bağımlı güvenirliği incelendiğinde tüm faktörler ve toplam puan ile DOÖ arasında pozitif yönlü orta derece ilişkiler olduğu görüldü. TRKÖ-H Toplam Puan ortalaması 29,63, DOÖ toplam puanın ortalaması 33,32 idi (35) (Tablo 3).

TRKÖ-H'nin İç Tutarlılığı

TRKÖ-H'nin iç tutarlılığı her üç faktör ve tüm maddeler için son derece yüksek değerlere sahipti. En yüksek iç tutarlılık değeri "Gelecekte Telerehabilitasyon Kullanma Niyeti'' boyutu için bulundu. TRKÖ-H'nin mükemmel test-tekrar test güvenirliğine sahip olduğu görüldü (Tablo 4).

TR Kabulü

TRKÖ-H toplam puanları için kadın ve erkek katılımcılar arasında fark olduğu, rehabilitasyon hizmetlerinden yararlanan erkek hastalar/bakım verenlerin TR kabulünün kadınlardan daha yüksek olduğu görüldü (p<0,001). Hasta/bakım verenlerden eğitim düzeyi daha yüksek olan katılımcıların TR kabullerinin daha yüksek olduğu görüldü (p<0,05). Hastalar/bakım verenlerinde gelir durumu, günlük telefon ve internet kullanım süreleri ile TR kabulü arasındaki ilişkiler incelendiğinde gelir durumu ile TR kabulü arasında ihmal edilebilecek derecede düşük şiddetli pozitif yönlü ilişki olduğu görüldü (p<0,007). Akıllı telefon ve internet kullanma süreleri ile TR kabulü arasında da düşük şiddetli pozitif yönde ilişkiler mevcuttu (p<0,05). Pediatrik rehabilitasyon ve ortopedik rehabilitasyon tanı gruplarında yer alan katılımcıların TR kabulleri arasında fark olduğu, ortopedik rehabilitasyon tanı grubunda yer alan katılımcıların TR kabullerinin daha yüksek olduğu görüldü (p<0,05). Daha genç yaş grubunda olan hasta/bakım verenlerin TR kabullerinin daha yüksek olduğu görüldü (p<0,05). İlgili veriler Tablo 5'te sunuldu.

TARTIŞMA

Çalışmamız; hastaların TR farkındalığını değerlendirmek için geliştirilen, 12 maddeden oluşan, orijinal dili İngilizce olan TRKÖ-H'yi Türkçeye uyarlamak ve geçerlik ve güvenirliğini araştırmak amacıyla gerçekleştirdi. Ölçeğin Türkçeye çeviri basamağı ardından gerçekleştirilen analizler sonucunda TRKÖ-H 11 maddeye indirgendi. Çalışmamız sonucunda TRKÖ-H'nin Türkçe versiyonunun geçerli ve güvenilir olduğu gösterildi.

Açıklayıcı faktör analizine geçmeden önce ölçekteki maddelerin ölçek toplam puanına göre ilişkisini görmek için korelasyona dayalı madde analizi yapıldı. Bu analizin amacı ölçekteki maddelerin ölçme gücünün belirlenmesi, geçerliliği ve güvenirliği en yüksek düzeyde tutabilecek maddelerin ölçeğe dahil edilmesidir (36). Korelasyona dayalı madde analizi sonuçları ölçekteki maddelerin birbirleriyle yakından ilişkili olduğunu göstermekteydi. Elde edilen yüksek korelasyonlar ölçekten madde çıkarılmasına gerek olmadığını gösterdi. On iki maddelik ölçeğin genel güvenirlik sonuçları incelendiğinde ölçeğin güvenirliğinin yüksek seviyede olduğu belirlendi.

Bir ölçek var olan yapının tam olarak ne olduğu, kaç faktörden oluştuğu ve ölçekteki hangi maddelerin hangi faktörlere yüklendiği, hangi maddelerin varyansı açıklayıp açıklamadığı yani ölçme amacına ulaşıp ulaşmadığını belirlemek için faktör analizi kullanılmaktadır (37). Çalışmamızda da bu amaçlarla TRKÖ-H için açıklayıcı faktör analizi yapıldı. On iki maddelik ölçme aracı için toplam varyansın %85,247'sini açıklayan 3 faktör elde edildi. Her üç faktörün de toplam varyansa %5'ten fazla katkı sağladığı görüldü. Birden fazla faktöre yüklenen madde olmadı. On iki maddelik ölçekte tüm maddelerin faktör yüklerinin 0,40'ın üstünde olduğu (0,615-0,915) görüldü. Dolayısıyla ölçekteki maddelerin ölçme amaçlarını gerçekleştirdikleri görüldü. Çalışmamamızda elde edilen faktörler orijinal ölçekteki faktörler ile aynı sayıdaydı, ayrıca soruların ilgili faktörlere dağılımı orijinal ölçekteki dağılım ile eşleşmiş durumdaydı. Bu sonuçlar doğrultusunda açıklayıcı faktör analizi ile TRKÖ-H'den madde çıkarılmasına gerek olmadığı görüldü. TRKÖ-H'nin faktör dağılımlarına baktığımızda faktör 1'de (Algılanan Fayda) madde 1-6, faktör 2'de (Algılanan Kullanım Kolaylığı) madde 7-9, faktör 3'te (Kullanma Niyeti) madde 11, 12'nin yer aldığı belirlendi.

Yapı geçerliğini tespit etmek için yapılan doğrulayıcı faktör analizi sonucunda uyum değerlerinin kısmen yeterli olduğu görüldü, ancak regresyon katsayısı düşük olan Madde 10'un modelden çıkarılmasına karar verildi. Doğrulayıcı faktör analizi belirlenen faktörler arasında yeterli düzeyde ilişkinin olup olmadığını, hangi değişkenlerin hangi faktörlerle ilişkili olduğunu, modeli açıklamakta yeterli olup olmadığını sınamak için kullanılır (38). Bu nedenle regresyon katsayısı düşük olan Madde 10'un algılana kullanım kolaylığı faktörüyle yeterince ilişkili olmadığı düşünüldü ve Madde 10 ölçekten çıkarıldı. Tekrarlanan analizde model uyum indeksleri kabul edilebilir bulundu. Analizlerden sonra ölçeğe son hali verildi, buna göre ölçek 11 maddeden oluşmakta, madde 1-6 telerehabilitasyonun algılanan faydası boyutunda, madde 7-9 telerehabilitasyonun algılanan kullanım kolaylığı boyutunda, madde 11,12 ise gelecekte telerehabilitasyon kullanma niyeti boyutunda yer almaktaydı.

Anketin geliştirildiği orijinal çalışmada ölçeğin kapsam ve yapı geçerliği incelenmiştir. Kapsam geçerliği; TR ile ilgili alanlarda uzman bir grup ve bir grup potansiyel TR kullanıcısının görüşlerinden yararlanılarak değerlendirilmiştir. Başlangıçta tek ölçek olarak geliştirilen TRKÖ' nün biri sağlık profesyonelleri diğeri de hastalar için olmak üzere 2 ölçek olarak tasarlanması uzmanlar tarafından önerilmiştir. Ölçeğin her iki versiyonu da yapı ve kapsam geçerliği açısından yeterli bulunmuştur (39).

TRKÖ-H'nin Ölçüt Bağımlı Güvenirliği

TRKÖ-H'nin DOÖ ile ölçüt bağımlı güvenirliği incelendiğinde tüm faktörler ve toplam puan ile DOÖ arasında pozitif yönlü orta derece ilişkiler olduğu görüldü. Hasta/bakım verenlerinin eğitim durumlarının geniş bir yelpazede yer aldığı görüldü. Bu durumun da dijital okuryazarlık seviyesini etkileyebileceği düşünülebilir. Hastalar/bakım verenlerinin verileri incelendiğinde eğitim seviyesi ve yaş açısından daha heterojen bir grubun var olduğu bu durumun da dijital okuryazarlık seviyesini etkileyebileceği düşünülebilir. Bu sayede iki ölçek arasındaki ilişki hastalar/bakım verenlerinin verilerinde net ortaya konmuş olabilir. Literatürde geriatrik popü-

lasyonda tele-sağlık hizmeti alma niyetlerini araştıran bir çalışmada dijital okuryazarlık düzeyinin, dijital kapasite kullanımı için önemli rol oynadığı ve tele-sağlık hizmeti alma niyetlerini desteklediği sonucuna varılmıştır (40). Bizim çalışmamızda da dijital okuryazarlık seviyesi ile TRKÖ-H tüm faktörler ve toplam puan arasında pozitif ilişkiler olduğu ve dijital okuryazarlığın TR kabulünü desteklediği sonucuna ulaşıldı.

TRKÖ-H'nin İç Tutarlılığı

TRKÖ-H'nin iç tutarlılığı her üç faktör ve tüm maddeler için son derece yüksek değerlere sahipti. En yüksek iç tutarlılık değeri "Gelecekte Telerehabilitasyon Kullanma Niyeti'' boyutu için bulundu. Orijinal çalışmada (39) da ölçeğin iç tutarlılığı her üç faktör için son derece yüksek değerlere sahipti. Orijinal çalışma da en yüksek iç tutarlılık değeri ''Gelecekte Telerehabilitasyon Kullanma Niyeti'' boyutu için bulundu. Boyutların iç tutarlığının yüksek olması boyuttaki maddelerin birbirleri ile uyumlu olması anlamına gelmektedir. Bu uyum da güvenirliği artırmaktadır. Bu bağlamada hem faktörlerin iç tutarlığının yüksek değerlere sahip olması hem de ölçeğin tüm maddeleri bir arada incelendiğinde iç tutarlığının yüksek olması ölçeğin güvenirliğinin yüksek olduğunu gösterdi.

TRKÖ-H'nin Test-Tekrar Test Güvenirliği

TRKÖ-H'nin mükemmel test-tekrar test güvenirliğine sahip olduğu görüldü. Test-tekrar test güvenirliği bir ölçme aracının aynı denek grubuna belirli bir zaman aralığı sonrasında yeniden uygulanması ile değerlendirilmektedir. Bu zaman aralığının ardından katılımcıların ilgili sorulara benzer şekilde yanıtlar vermeleri söz konusu ölçme aracının yüksek güvenirliğe sahip olduğunu ifade etmektedir. Çalışmamızda ilk değerlendirmeden 15 gün sonra TRKÖ-H ölçeği katılımcılara yeniden uygulandı. İlk ve ikinci değerlendirme arasında hem boyutlar hem de ölçek geneli için yüksek ICC değerlerinin bulunması ölçeğin yüksek güvenirliğe sahip olduğunu gösterdi. Ölçeğin geliştirildiği orijinal çalışmasında Almojaibel ve arkadaşları (39) çalışmadaki ana hedeflerini ölçeği geliştirme ve ölçeğin geçerliğini belirleme olarak belirtmişlerdir. Orijinal çalışmada test-tekrar test uygulaması yapılmamış, ICC değerleri hesaplanmamıştır sonuçların karşılaştırılması bu nedenle mümkün olmamaktadır.

TR Kabulü

TRKÖ-H için kadın ve erkek katılımcılar arasında fark olduğu, rehabilitasyon hizmetlerinden yararlanan erkek hastalar/bakım verenlerin TR kabulünün erkeklerde daha yüksek olduğu görüldü. Toplumda erkeğe yüklenen para kazanarak aileyi geçindirme rolünden ötürü erkekler kadınlara göre iş hayatında daha çok var olmaktadır (41). Yoğun iş hayatında erkeklerin rehabilitasyon merkezine gitmek amacıyla vakit bulamayışından dolayı uzaktan rehabilitasyon hizmeti almaya daha olumlu baktıklarını düşünmekteyiz.

Hastalar/bakım verenlerin de gelir durumu, günlük telefon ve internet kullanım süreleri ile TR kabulü arasındaki ilişkiler incelendiğinde gelir durumu ile TR kabulü arasında ihmal edilebilecek derecede düşük şiddetli pozitif yönlü ilişkiler olduğu sonucuna ulaşıldı. Bizim çalışmamıza benzer bir sonucu olan çalışmada tele-sağlık kullanımı ile sosyoekonomik farklılıklar arasındaki ilişki incelenmiş ve aralarında pozitif yönde ilişki olduğu sonucuna ulaşılmıştır (42). Ayrıca akıllı telefon ve internet kullanma süreleri ile TR kabulü arasında da düşük dereceli pozitif yönde ilişkiler olduğu görüldü. Akıllı telefon ve internet kullanma süreleri ile TR kabulü arasında pozitif yönde ilişki olması çalışmamızda beklentimiz dahilindeydi. TR'nin etkin olarak kullanılması için teknoloji kullanımına yatkın olmanın bir avantaj olabileceği düşünülmektedir (43).

Ortopedik rehabilitasyon tanı grubu ile pediatrik rehabilitasyon tanı grubunda yer alan katılımcıların TR kabulleri karşılaştırıldığında ortopedik rehabilitasyondaki katılımcılarının kabulünün yüksek olması ortopedik rahatsızlıklarda TR kullanımı ve pediatrik rahatsızlıklarda TR kullanımı açısındaki farklılıklardan kaynaklanıyor olabilir. Özellikle ağır etkilenimli pediatrik hastalarda fizyoterapistin birebir yaptığı uygulamalar, fasilitasyon, inhibisyona yönelik uygulamalar ve el temasları önemli olabilir. Çalışmamızda pediatrik popülasyona ait verilerin bakım verenler tarafından sağlandığı düşünülürse bakım verenler bu uygulamaların telerehabilitasyonla yapılmasının güç olduğu kanaatine varmış olabilirler. Her ne kadar TRKÖ-H için bir kesme değeri belirlenmemiş olsa da çalışmamıza dahil edilen her hasta grubu için elde edilen TRKÖ-H ortalama puanları 22 puanın (Tüm sorular için 1=Kesinlik-

le katılmıyorum; 2=Katılmıyorum şeklinde puanlanması durumunda alınabilecek en yüksek puan) üzerindedir. Bu da katılımcıların TR'ye olumlu bakışlarını göstermektedir. Sistematik bir derlemede çocuklarda COVID-19 sırasında fizik tedavide TR etkinliği inceleyen çalışmalar incelenmiş ve dahil edilen çalışmaların hem rehabilitasyon uzmanlarının hem de çocukların ebeveynlerinin veya bakıcılarının uzaktan sağlanan TR hizmetlerinden memnun olduğunu ortaya koymuştur (44).

Çalışmamızda hasta grubunda her yaş grubundan katılımcılara ulaşmak hedeflenmişti ancak pandemi sebebiyle riskli bir durumda olan geriatrik popülasyon rehabilitasyon merkezlerine gelmeyi tercih etmediği için bu bireylerin çalışmaya dahil edilmesinde güçlükler oluşmuştu. Buna karşın çalışmamıza dahil edilen bireyler 30 yaş altı, 30-49 yaş arası ve 50 yaş ve üzeri olarak üç yaş grubuna ayrılabildi. Böylece farklı yaş gruplarındaki bireylerin de TR kabulleri ortaya konabildi. Gelecekteki çalışmalarda daha spesifik tanı gruplarında ve yaş aralıklarındaki bireylerin TR kabulü incelenebilir. Ayrıca hastalardan verileri hem yüz yüze hem de çevrimiçi bir şekilde almak daha çeşitli yaş gruplarına ulaşmada fayda sağlayabilir.

Çalışmamızın çeşitli kısıtlılıkları bulunmaktaydı. Çalışmamıza dört faklı rehabilitasyon alanında hizmet almakta olan katılımcılar dahil edilmişti. Ancak pulmoner rehabilitasyon almakta olan katılımcıların sayısı son derece azdı. İleriki çalışmalarda hem pulmoner rehabilitasyon hem de kadın sağlığı, onkolojik rehabilitasyon, sporcu sağlığı, geriatrik rehabilitasyon gibi çeşitli alanlarda hizmet almakta olan bireylerin dahil edilmesi TR kabulünü belirlemek açısından daha ayrıntılı bilgiler sağlayacaktır. Ayrıca mevcut bilişsel problemleri ve iletişim güçlükleri nedeniyle pediatrik rehabilitasyon almakta olan katılımcıların TR kabulü bakım verenleri aracılığı ile dolaylı olarak değerlendirilebildi. Bu da asıl hizmet kullanıcılarının kabul durumu ile ilgili bilgilerin ortaya konulmasında yeni çalışmalara ihtiyaç duyulmasına neden olabilir.

TRKÖ-H'nin Türkçeye adaptasyonunun yapıldığı çalışmamızın sonucunda hasta/bakım verenlerde TR kabulünü belirlemede kullanılan TRKÖ-H'nin herhangi bir rehabilitasyon programına devam etmekte olan hasta/bakım verenlerde TR kabulünü ve farkındalığını belirlemek için uygun, geçerli ve güvenilir bir araç olduğu ortaya konuldu. Çalışmaya dahil ettiğimiz örneklemde genç, eğitim düzeyi yüksek, dijital okur yazarlık seviyesi yüksek bireylerin ve ortopedik rehabilitasyon almakta olan bireylerin en yüksek TR kabulüne sahip oldukları görüldü. Ülkemizde yapılan çalışmalarda TR'nin etkinliği genellikle yapılan müdahale ile ilişkili değerlendirme yöntemleri kullanılarak analiz edilmiştir. TR'ye özgü tasarlanan ve TR kabulünü değerlendiren TRKÖ-H, TR kabulünün daha standardize değerlendirilmesini sağlayacak gelecekte yapılacak çalışmalara ve klinik uygulamalara katkı sağlayacaktır.

Destekleyen Kuruluş: Bulunmamaktadır.

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Sefa KILIÇ, MSc.[1]
Kübra ALPAY, PT, PhD, Asist. Prof.[2]
Emine ATICI, PT, PhD, Assoc. Prof.[3]
Mehmet SOYAL, Assoc. Prof.[4]
Güldal INAL-GÜLTEKIN, Prof. Dr.[5]

1 *Spor Health Center, Bezmialem Vakıf University, Istanbul, Turkey.*
2 *Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bezmialem Vakıf University, Istanbul, Turkey.*
3 *Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Istanbul Okan Unversity, Istanbul, Turkey.*
4 *School of Physical Education and Sports, Istanbul Gelisim University, Istanbul, Turkey.*
5 *Department of Physiology, Faculty of Medicine, Istanbul Okan University, Istanbul, Turkey.*

Correspondence (İletişim):

Güldal INAL GÜLTEKIN
Address: Istanbul Okan University, Faculty of Medicine, Department of Physiology Istanbul/ Türkiye, +902166771630-3855, guldal.inal@okan.edu.tr, Orcid: 0000-0002-8313-6119

Sefa KILIÇ
e-mail: sefaklc92@gmail.com
Orcid Id: 0000-0003-3477-930X

Kübra ALPAY
e-mail: kubraalpay@hotmail.com
Orcid Id: 0000-0003-4807-6496

Emine ATICI
e-mail: emimert@gmail.com
Orcid Id: 0000-0002-6547-4798

Mehmet SOYAL
e-mail: mehmetsoyal3838@hotmail.com
Orcid Id: 0000-0002-6547-4798

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THE EFFECT OF ANAEROBIC FATIGUE ON PROPRIOCEPTION IN ADOLESCENT FEMALE BASKETBALL PLAYERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: Muscle fatigue is known to alter the proprioceptive system, the central proprioception process, and power generation capacity. This study aims to determine the effect of anaerobic fatigue on lower-extremity proprioception in adolescent female basketball players.

Methods: The study included licensed female basketball players (n=30) between the ages of 12 and 16. Their dominant lower extremities were evaluated for knee joint position-sense measurements. Active and passive knee joint position senses were measured with an isokinetic dynamometer at 30° and 60° degrees prior to, immediately after anaerobic fatigue, and finally after 10 minutes of the recovery period. The Wingate Anaerobic Strength Test was used to induce anaerobic fatigue. We documented the knee joint position sense of each participant.

Results: Following a 30-second anaerobic fatigue, a significant reduction in the sense of active joint perception at 30° and 60° knee flexion was observed compared to baseline values (p> 0.017). The knee joint's proprioception at 30° and 60° flexion returned to baseline levels after a 10-minute recovery from fatigue. The passive joint perception did not show any statistical changes.

Conclusion: Anaerobic fatigue reduces knee proprioception in adolescent female basketball players. Moreover, proprioceptive sensitivity can return to baseline levels with a recovery time of as little as 10 minutes.

Keywords: Adolescent, Basketball, Fatigue, Proprioception

ANAEROBİK YORGUNLUĞUN ADÖLESAN KIZ BASKETBOL OYUNCULARINDA PROPRIOSEPSIYON ÜZERİNDEKİ ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Kas yorgunluğunun proprioseptif sistemi, merkezi propriosepsiyon sürecini ve güç üretim kapasitesini değiştirdiği bilinmektedir. Bu çalışma, adölesan kız basketbol oyuncularında anaerobik yorgunluğun alt ekstremite propriosepsiyonu üzerindeki etkisini belirlemeyi amaçlamaktadır.

Yöntem: Çalışmaya 12-16 yaşları arasında lisanslı kız basketbol oyuncuları dahil edildi (n=30). Dominant alt ekstremiteleri, diz eklemi pozisyon hissi ölçümleri için değerlendirildi. Aktif ve pasif diz eklemi pozisyon duyusu, izokinetik dinamometre ile istirahatte (test öncesi), anaerobik yorgunluktan hemen sonra ve 10 dakikalık dinlenme döneminden hemen sonra 30° ve 60° derecelerde ölçüldü. Anaerobik yorgunluk oluşturmak için Wingate Anaerobik Güç Testi kullanıldı. Her katılımcı için test öncesi diz eklemi pozisyon algıları kaydedildi.

Sonuçlar: 30 saniyelik anaerobik yorgunluktan sonra, istirahat değerlerine kıyasla 30° ve 60° diz fleksiyonunda aktif eklem pozisyonu algısında önemli bir azalma gözlendi (p>0,017). Yorgunluktan sonra 10 dakikalık bir iyileşmenin ardından, 30° ve 60° diz fleksiyonunda aktif eklem pozisyonu algısı istirahat seviyelerine döndü. Pasif eklem algısında istatistiksel bir değişim gözlenmemiştir.

Tartışma: Anaerobik yorgunluğun adölesan kız basketbol oyuncularında diz proprioception'ını azalttığı belirlendi. Ayrıca, proprioseptif duyarlılığın 10 dakikalık kadar kısa bir iyileşme süresi ile bazal seviyelere döndüğü gözlemlenmiştir.

Anahtar Kelimeler: Adölesan, Basketbol, Yorgunluk, Propriyosepsiyon

INTRODUCTION

Several variables combine to cause fatigue, which decreases muscle contraction strength or power and impairs sports performance (1,2). Muscular fatigue is defined as the inability to generate or sustain a specific force through muscular contraction, which contributes to musculoskeletal problems. On a molecular level, fatigue can be caused by an imbalance of K+ ions in the sarcolemma, the amount of oxygen in the muscle, and the rates at which oxygen is lost and gained (3,4). However, in broad terms, a key indicator of fatigue is a decline in proprioception ability, which leads to a decrease in performance (5). The level of weariness in different sports directly impacts competition outcomes.

Proprioception is the body's ability to sense its position and movement in space. It is essential for maintaining balance, coordination, and joint stability (6,7). Proprioceptors are located throughout the body, including in the muscles, tendons, ligaments, and joints. These receptors send signals to the brain, which uses them to create a map of the body's position and movement (8).

Proprioception is crucial for sports performance. Athletes with strong proprioception exhibit enhanced movement control and injury prevention (9). For instance, a basketball player with proficient proprioception may safely land after a jump shot, even with their eyes closed.

Injuries, fatigue, and other factors can diminish proprioception (10). A sprained ankle can damage the proprioceptors in the ankle joint, making it more difficult to balance and walk. Muscle fatigue, which impairs proprioception, makes athletes more susceptible to injuries (8).

Proprioception training can help to improve joint stability, reduce the risk of injury, and enhance athletic performance (9). There are many different types of proprioception exercises, such as balance board training, wobble board training, and plyometric exercises.

Basketball is a team sport with repetitive transitions between offense and defense and involves movements on several planes (11). It has a high risk of injury among team sports, as it involves running, cutting, jumping, and landing (12,13). Reports particularly highlight the high frequency of injuries in the lower extremities (14,15), including the Women's National Basketball Association (WNBA) (16). Female adolescent athletes are more prone to injuries due to anatomical variables such as a wider pelvis and greater knee valgus, as well as biomechanical variations during physical activities such as running, jumping, landing, and sudden changes in direction. The control of the dynamic movements in basketball involves not only alpha motor neurons and the muscle fibers, but also muscle spindle receptors and gamma motor neurons in the fusiform muscles, which are components of proprioception for both dynamic and static movement control, as well as Golgi tendon organs that are sensitive to muscle tension (17).

In part due to the ongoing developmental process of adolescent girls, it is critical to examine the risk factors for injury in adolescent female athletes (18). Studying the effects of anaerobic strain on proprioception in basketball is essential for planning effective proprioception training programs and thus minimizing the risk of injury (19-21). Therefore, this study aims to examine the impact of anaerobic fatigue on lower extremity proprioception in adolescent female basketball players, with a 30° and 60° knee flexion angles that have not been previously investigated.

METHODS

Study Design and Participants

The research was conducted between 03.02.2020 and 17.02.2020 in Bezmi Alem University Athlete Health Centre laboratories. Athletes were tested prior to fatigue, immediately after, and finally following a 10-minute rest. The study was approved by the Istanbul Okan University Clinical Research Ethics Committee (No. 37/31.01.2020).

To determine the sample size, we used the G-Power 3.1 software (Universität Düsseldorf, Germany). Based on previous research (22), which found a significant increase in knee fatigue-induced angular error (effect size: Cohen's d = 1.16), we anticipated a similar effect in our study. Aiming for 80% power and 95% confidence, we calculated a minimum sample size of 26 participants. This study includ-

ed 30 licensed female basketball players aged between 12 and 16 years of age. 'Parental Consent Forms' were collected after informing the participants and parents of the study and the tests.

Participants with chronic metabolic disorders, cardiac or respiratory system conditions, and those with a history of surgery or a lower-limb injury during the previous six months were not admitted to this study. Each participant initially underwent an orthopedic evaluation of the hip, knee, and ankle joints. Based on the test findings, the participants who did not have any health conditions that would prevent them from participating in the study were admitted. The participants were asked not to join training programs the day before and on the day of evaluation. Initial proprioception data of participants were collected prior to anaerobic exhaustion, which was followed by an immediate proprioception data collection, and then, following a 10-minute recovery phase, a third data collection was completed. The participants were asked to use their dominant legs for the evaluation for proprioception.

Outcome Measure

Proprioception assessment was performed by measuring active and passive joint position sense at target angles of 30° and 60° of knee flexion with an isokinetic dynamometer (CSMI, Cybex Humac Norm, USA). The 30° and 60° knee angles are frequently used in activities such as jumping, running, and sudden direction changes, especially among athletes. Therefore, evaluating proprioception at these angles helps to more accurately predict athletes' performance and injury risk (23). The participants were seated in the dynamometer chair with their eyes closed and used headphones. The evaluated leg was fixed with a belt from the distal portion of the tibia by a Velcro strap, and the opposite limb was strapped to the axis of the dynamometer (24). During the measurement, the participant's knee joint was passively brought from 90° of knee flexion to the target angles and held in this position for 5 seconds before returning to its original position. For active joint position sense, participants actively moved the knee joint to reach the target angle, while for passive measurement, the knee joint was passively moved and participants were asked to identify the target angles. Measurements were taken in triplicate, and joint position sense was reported as the absolute angular error (AAE), defined as the difference between the target position and the reproduced position without considering the direction of the difference (25,26).

Anaerobic Fatigue Procedure

A Wingate anaerobic test protocol was implemented to induce anaerobic fatigue using a bicycle ergometer with magnetic and air resistance, calibrated according to body weight (Wattbike Ltd., Nottingham, England) (27-29). Participants received a briefing about the exhaustion strategy and completed a 5-minute warm-up (60–70 rpm) before the anaerobic test. The test lasted for 30 seconds with a resistance of 0.075 kg/body mass, during which participants were encouraged to exert maximum effort. Heart rate was collected at rest, immediately after the Wingate test, and during recovery using a pulse oximeter to indicate physiological stress. The workload was calculated with the formula: 100×pulses/maximal heart rate

Statistical Analyses

Data analysis was performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics for categorical and continuous variables (mean, standard deviation, median, minimum, maximum, count, and percentage) were reported. Homogeneity of variances was tested with Levene's test, and the normality assumption was assessed using the Shapiro-Wilk test. For normally distributed data, parametric analyses were used, and non-parametric analyses were applied to non-normally distributed data. Active and passive repeated measurements were analyzed with the Friedman test, and pairwise analyses were conducted with the Wilcoxon test using the Bonferroni correction for statistical significance. Significance was set at $p < 0.05$.

RESULTS

The participants had an average of 4 years in sports (min 2–max 5 years). Demographic characteristics are outlined in Table 1. Comparisons of active and passive joint position sense at 30° and 60° knee flexion, heart rate, and workload at rest, post-fatigue, and recovery periods are presented in

Table 1. Demographic Characteristics of Female Adolescent Participants

	Mean ± SD	Min-Max
Age (years)	13.96 ± 0.88	13.00 ± 16.00
Height (cm)	171.23 ± 7.29	158.00 ± 185.00
Weight (kg)	58.21± 9.37	37.00 ± 76.00
BMI (kg/m²)	19.71 ± 2.14	14.80 ± 23.60
Muscle mass (kg)	43.66 ± 6.19	30.90 ± 57.60
Fat mass (kg)	11.71 ± 3.75	3.80 ± 18.40
Fat rate (%)	19.74 ± 4.32	9.40 ± 26.00
Year of sport	4.03 ± 0.96	2.00 ± 5.00

Summary Statistics are Presented as Mean±Standard Deviation and Median (Minimum, Maximum) for Numerical Data; BMI: Body Mass Index, SD: Standard Deviation

Table 2. The average fatigue heart rate was 171.9 ± 4.2 bpm, with workload calculated as 83% of the maximum heart rate. Using the Karvonen formula (31), the percent workload during fatigue was 72.70 ± 2.90%.

Significant differences were found between initial and post-fatigue measurements, as well as post-fatigue and recovery measurements, for active joint position sense at both 30° and 60° knee flexion ($p < 0.017$). No significant differences were found between initial and recovery parameters. However, passive joint position sense did not differ significantly between the two angles. The pairwise analysis also showed statistically significant differences in heart rate and workload between initial, post-fatigue, and recovery periods ($p < 0.017$).

DISCUSSION

The purpose of this study was to examine the effect of anaerobic fatigue on lower extremity proprioception in adolescent female basketball players, focusing on knee joint proprioception at 30° and 60° knee flexion angles. The findings revealed that anaerobic fatigue led to a significant decrease in knee joint proprioception in terms of position sense at 30° and 60° knee flexion in adolescent female basketball players. Suggesting that fatigue negatively impacts proprioceptive accuracy in this population.

Fatigue impacts proprioception in both sedentary and athletic individuals, with muscle exhaustion causing neuromuscular deficits that heighten injury risk and reduce sports performance. We may express that the anaerobic fatigue on the lower extremity may threaten knee joint proprioceptive accuracy among adolescent female basketball players. Notably, proprioception was restored to resting levels following a 10-minute recovery period, and it may be feasible to express the importance of rest periods after bouts of anaerobic ex-

Table 2. Active and Passive Knee Joint Position Sense Measurements for 30° and 60° Angles using the Isokinetic Dynamometer

		X ± SD	Rest	Immediately post-fatigue	Recovery	P¹	P²	P³
			X ± SD	X ± SD				
AAE	**30°**	**Active**	1.38 ± 0.88	2.55 ± 1.09	1.66 ± 1.27	**<0.001***	0.220	**0.009***
		Passive	1.12 ± 0.79	1.39 ± 0.75	1.18 ± 0.93	0.019	0.954	0.074
	60°	**Active**	1.33 ± 0.90	2.41 ± 0.94	1.31 ± 0.71	**<0.001***	0.756	**<0.001***
		Passive	1.15 ± 0.88	1.31 ± 0.94	1.05 ± 0.68	0.123	0.762	0.051
%MHR			79.90 ± 9.50	171.90 ± 4.20	91.80 ± 2.90	**<0.001***	**<0.001***	**<0.001***
38.70 ± 4.60 **83.30 ± 2.10**			44.50 ± 5.00	**<0.001***	**<0.001***	**<0.001***		

*: Wilcoxon Sign Test, Statistical Significance Level P<0.05; AAE: Absolute Angular Error, MHR: Maximal Heart Rate. P¹: Between Rest and Post-Fatigue, P²: Between Rest and Recovery, P³: Between Post-Fatigue and Recovery.

ercises for preventive measures among adolescent female basketball players. This outcome may also present the uniqueness of this study since the previous proprioception studies primarily involved participants aged 20 or older as 30-33 years old, while this study focused on adolescent female basketball players who are in growing age and open for risks of injuries (Harris et al., 2021). Therefore, this study contributes to the existing body of research by focusing specifically on adolescent female basketball players that are having a critical period for neuromuscular development, and the findings of this study highlight the vulnerability of young female athletes to fatigue-induced proprioceptive deficits. On the other hand, the impact of anaerobic fatigue on proprioception of soccer and football players has also shown similar findings, where fatigue due to lower extremity muscle exhaustion reduced proprioceptive accuracy (7, 28).

Thus, these results align with previous studies indicating that fatigue impairs proprioception in athletes (7,28). Specifically, it has been shown that muscle fatigue, especially from anaerobic exercises, can cause temporary deficits in proprioception, which increases the risk of injury. Our findings echo those of Miura et al. (2004), who demonstrated that fatigue impairs proprioception in knee joint repositioning accuracy, which could lead to greater susceptibility to injuries (34).

Similarly, decreased proprioception after lower extremity fatigue has been reported in uninjured male football players (31) and following quadriceps muscle exhaustion in healthy young people (29). Miura et al., compared the effects of local and general fatigue on knee joint proprioception in healthy males (34, 35). They reported no change in proprioceptive sense after local fatigue but a decrease after general fatigue, indicating temporary impairment of muscle spindle function (34).

Another important aspect of our study is the use of anaerobic fatigue induced by the Wingate test, a common method for evaluating short-burst exertion in basketball and other high-intensity sports. Since it mimics the type of anaerobic exertion players may experience during actual competition, it provides a realistic context for understanding how fatigue may affect proprioception during a game. Therefore, the strength of our study is that it supports the notion that proprioception plays a vital role in injury prevention and players' performance, particularly in sports involving anaerobic movements with frequent changes in direction and intense physical demands, like basketball.

However, there are certain limitations to this study that must be considered. First, the sample size was limited to players from a single club, which may restrict the generalizability of the results to other populations of adolescent female basketball players. Future studies should aim to include a larger, more diverse sample to confirm these findings across different settings. Additionally, although the study assessed the effects of anaerobic fatigue on knee proprioception, it did not measure blood lactate levels or other physiological markers, which could have provided a more comprehensive understanding of the fatigue-induced changes in proprioception. Future research could include these measures to offer a more complete picture of the physiological responses to anaerobic fatigue.

In conclusion, this study provides valuable insights into how anaerobic fatigue affects proprioception in adolescent female basketball players. The findings suggest that fatigue-induced changes in proprioception can increase the risk of injury, highlighting the importance of incorporating recovery periods and fatigue management strategies into training regimens. Further research is needed to explore the long-term effects of repeated fatigue on proprioception and to develop effective strategies for mitigating these effects to improve athlete performance and safety.

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Veysel ALCAN, PhD[1*]
Murat ZİNNUROĞLU, MD, PhD.[2]
Abdulvahap KAHVECİ, MD, PhD[3]
Hilmi UYSAL, MD, PhD.[4]
Erdem DEMİR, PT, PhD[5]
Hakan TÜZÜN, MD, PhD[6]

1 Department of Electrical and Electronics Engineering, Faculty of Engineering, Tarsus University, Mersin, Turkiye,
2 Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Gazi University, Ankara,Turkiye,
3 Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Ankara University, Ankara,Turkiye,
4 Department of Neurology , Faculty of Medicine, Akdeniz University, Antalya, Turkiye,
5 Department of Physiotherapy, Alanya University, Antalya, Turkiye,
6 Department of Public Health, Faculty of Medicine, Gazi University, Ankara, Turkiye,

Correspondence (İletişim):

Veysel ALCAN, PhD.
Tarsus University, Faculty of Engineering, Takbas Mah. Kartaltepe Sk. 33400, Tarsus Mersin, Turkiye; E-mail: alcanveysel@tarsus.edu.tr, ORCID: 0000-0002-7786-8591

Murat ZİNNUROĞLU
E-mail: muratz@gmail.com
ORCID: 0000-0003-1077-6753

Abdulvahap KAHVECİ
E-mail: abdulvahap_kahveci@hotmail.com
ORCID: 0000-0002-2611-2372

Hilmi UYSAL
E-mail: hilmi.uysal@gmail.com
ORCID: 0000-0002-6063-377X

Erdem DEMİR
E-mail: erdem.demir@alanyauniversity.edu.tr
ORCID: 0000-0002-0247-9006

Hakan TÜZÜN
E-mail: drtuzunh@yahoo.com
ORCID: 0000-0002-6376-8979

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THE BARRIERS AND FACILITATORS FOR WIDESPREAD USING SURFACE ELECTROMYOGRAPHY IN CLINICAL PRACTICE: A CROSS-SECTIONAL STUDY IN TURKIYE

ORIGINAL ARTICLE

ABSTRACT

Purpose: Surface electromyography (sEMG) is a non-invasive tool for understanding the mechanisms of neuromuscular systems, which provides very useful and important quantitative electrophysiological information as part of evidence-based practice. The sEMG has many applications across a wide variety of fields (e.g. in neurophysiology, physiotherapy, biofeedback, gait analysis, ergonomics, occupational medicine, neurorehabilitation, etc.). Although there are a great number of publications, books, tutorials, and advancements in sEMG, there remains a gap characterized by its lack of clinical acceptance. This study aimed to investigate facilitators and barriers to the widespread use of sEMG among clinicians.

Methods: An online survey with 46 items was conducted to potential practitioners of sEMG including medical doctors, physiotherapists, and non-clinical researchers. Descriptive statistics and cross-tabulation tests were employed.

Results: This study found that sEMG did not have high clinical acceptance despite a common perception of its clinical potential and benefits. It has been commonly used for research purposes. The major barriers were found as a lack of knowledge and experience about sEMG signals and systems due to the poor educational background of sEMG. When comparing the purpose of using sEMG, there were statistical differences in diagnosis (p=0.002) and research (p=0.004) but no differences in treatment (p=0.103). Significant statistical differences were also found among participants who took an sEMG course and those who did not (p=0.009).

Conclusion: The findings indicate that multidisciplinary bachelor's and master's programs, like a Dutch Model, are needed because advances in sEMG require new professional skills with medical and technical knowledge.

Keywords: Clinical Acceptability, Health Education, Healthcare Professionals, Medical Technology, Surface Electromyography

YÜZEY ELEKTROYOGRAFİSİNİN KLİNİK UYGULAMADA YAYGIN KULLANIMINA YÖNELİK ENGELLER VE KOLAYLAŞTIRICI FAKTÖRLER: TÜRKİYE'DE KESİTSEL BİR ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Yüzey elektromiyografisi (sEMG), nöromüsküler sistemlerin mekanizmalarını anlamaya yönelik kanıta dayalı uygulamanın bir parçası olarak çok yararlı ve önemli niceliksel elektrofizyolojik bilgiler sağlayan invazif olmayan bir araçtır. sEMG'nin çok çeşitli alanlarda (örneğin nörofizyoloji, fizyoterapi, biyolojik geri bildirim, yürüyüş analizi, ergonomi, mesleki tıp, nörorehabilitasyon vb.) birçok uygulaması vardır. sEMG'de çok sayıda yayın, kitap, eğitim ve ilerleme bulunmasına rağmen klinik kabulündeki eksikliği ile karakterize edilen bir boşluk bulunmaktadır. Bu çalışma, sEMG'nin klinisyenler arasında yaygın olarak kullanılmasının önündeki kolaylaştırıcı ve engelleyici faktörleri araştırmayı amaçlamıştır.

Yöntem: Tıp doktorları, fizyoterapistler ve klinik dışı araştırmacılar da dâhil olmak üzere potansiyel sEMG uygulayıcılarına 46 maddelik çevrimiçi bir anket uygulandı. Tanımlayıcı istatistikler ve çapraz tablolama testleri kullanıldı.

Sonuçlar: Bu çalışma, sEMG'nin klinik potansiyeli ve faydalarına ilişkin ortak algıya rağmen yüksek klinik kabulüne sahip olmadığını buldu. Yaygın olarak araştırma amacıyla kullanılmıştır. En büyük engellerin, sEMG' nin zayıf eğitim geçmişi nedeniyle sEMG sinyalleri ve sistemleri hakkında bilgi ve deneyim eksikliği olduğu bulundu. sEMG kullanım amacı karşılaştırıldığında, tanı (p=0,002) ve araştırma (p=0,004) açısından istatistiksel farklılıklar vardı ancak tedavide herhangi bir farklılık yoktu (p=0,103). sEMG kursu alan ve almayan katılımcılar arasında da anlamlı istatistiksel farklılıklar bulundu (p=0,009).

Tartışma: Bulgular Hollanda Modeli gibi multidisipliner lisans ve yüksek lisans programlarına ihtiyaç duyulduğunu göstermiştir. Çünkü sEMG'deki ilerlemelerin tıbbi ve teknik bilgi ile birlikte yeni mesleki beceriler gerektirdiğini göstermektedir.

Anahtar Kelimeler: Klinik Kabul Edilebilirlik, Sağlık Eğitimi, Sağlık Profesyonelleri, Tıp Teknolojisi, Yüzey Elektromiyografisi

INTRODUCTION

Surface electromyography (sEMG) is a non-invasive tool for understanding the mechanisms of neuromuscular systems. It provides very useful and important quantitative electrophysiological information for the diagnosis of disorders, the planning and the assessment of the outcomes of therapeutic interventions, the prognoses, and various aspects of the person's health status and functional limitation as part of evidence-based practice (EBP) (1). The sEMG has proliferating applications across a wide variety of fields, such as in neurophysiology, physiotherapy, biofeedback, gait analysis, human-machine interfaces, robotics, ergonomics, occupational medicine, neurorehabilitation, art, etc. (2). Although there are many publications, books, tutorials, and papers on the technological advancements of sEMG, the technique has limited clinical use among clinicians, and many challenges remain still unresolved (3-5). Unlike both electrocardiogram (ECG) and electroencephalogram (EEG) methods, clinical acceptance of sEMG has not yet reached a high level and varies according to application fields and education models in the countries.

The lack of acceptance of sEMG in clinical application is mainly relevant to the translation challenges between the clinical and research fields that can lead to a gap between the potential value of sEMG and its limited clinical applications (5). This may be the reason why the full potential of sEMG in clinical practice has not yet been realized. Some remarkable teaching initiatives have been implemented to understand and reduce this gap. For example, ISEK(International Society of Electrophysiology and Kinesiology) released a series of tutorials for clinicians (6). Additionally, a research topic has been recently carried out with the contribution of eighty authors (thirty-three engineers, sixteen medical doctors (MDs), eighteen physiotherapists (PTs), occupational therapists, and thirteen movement scientists) from seven countries (5). Within this research topic, research groups investigated the overall use of sEMG with perceptions of the benefits and barriers to using sEMG among potential practitioners (5,7- 9). Furthermore, novel hybrid educational models have been proposed in some countries to optimize diagnostic and treatment methods for healthcare professionals who provide technical and medical courses through interdisciplinary collaboration.

To add solution proposals to this existing project concerning the barriers, dissemination of research findings and education on sEMG are needed for its translation into practice. It is also needed to contribute some new information and the point of view from different countries for the identification of barriers to sEMG uptake and potential solutions. However, supporting information regarding the widespread use of sEMG is still unclear in many countries which can interact with factors such as socioeconomic status, educational systems, and ecosystems in clinical research. The barriers in clinical practice may include a lack of evidence for favorable outcomes, lack of consensus on its clinical utility, insufficient education or courses, and limited accessibility to EMG equipment. Therefore, we aimed to investigate the current use of sEMG, its advantages, facilitators, and barriers by using a survey among a variety of potential practitioners in Turkiye. Our motivation was to explore current trends, education, and clinical potential of sEMG and to offer a perspective how the widespread use of sEMG in clinics, research, and medical education models for further research.

METHODS

Study Design

The research design is a cross-sectional study conducted between November 15, 2020, and January 15, 2021. The study involved a multidisciplinary research team consisting of one MD from neurology, two MDs from physical medicine and rehabilitation (PM&R), one PT, one public health specialist, and one biomedical engineer. The online survey was developed based on a comprehensive review of the literature and input from experts in the field. It was designed to gather information on the current use of sEMG, perceived barriers and facilitators, and potential benefits. The survey included three sections with 46 items:

- Personal and work-related information.

- Factors affecting the adoption and application of sEMG.

- A 5-point Likert scale (1= strongly disagree, 5= strongly agree) assessing the potential benefits, barriers, and facilitating factors of sEMG.

Ethical approval for the study was obtained from Tarsus University Clinical Research Ethics Committee (date: 26/10/2020, no: 2020/44). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data Collection

The online survey conducted using Google Forms was accessible only in the Turkish language. We targeted potential sEMG practitioners in Turkiye, including Neurology MDs, PM&R MDs, Neurophysiologists, Kinesiologists, PTs, Sports Physicians, and other academic or research groups. We conducted a post hoc power analysis using G*Power 3.1 to determine the adequacy of our sample size for detecting significant differences in the use of sEMG among various professional groups. Based on an alpha level of 0.05, a medium effect size (Cohen's d = 0.5), and our total sample size of 104 participants, the power of the study was calculated. The power analysis revealed a power (1-β) of 0.80, which is generally considered acceptable for behavioral research. This suggests that our sample size is adequate to detect significant differences and draw valid conclusions

The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines (see Appendix 1) was considered (10). The main page of the survey started with the informed consent form explicitly mentioning the aim of the study, the research team, survey response time, and how to fill it. We used the e-mail lists and social media channels of some organizations, including the Turkish Physiotherapists Association, the Turkish Neurology Association, and the PM&R Specialists Association. Also, we scanned literature through databases (Pubmed, Web of Science, Google Scholar) using the Mesh keyword "surface electromyography" to reach potential users of sEMG in Turkiye. Invitations were sent to 332 potential users via email lists and social media channels of relevant organizations. We periodically sent reminder emails and messages to participants for fourteen weeks. To avoid receiving multiple responses from the same respondent, only one response was allowed per email address. We guarantee to protect all data to be kept confidential to be only used for the present study. We received 107 responses, of which 104 were complete and included in the analysis.

The research was conducted in Turkey at the national level, involving the Turkish Physiotherapists Association, the Turkish Neurology Association, the Turkish Physical Medicine and Rehabilitation Specialist Physicians Association, the Physical Medicine and Rehabilitation and Neurology Departments of University Medical Faculties, Sports Sciences Departments and Undergraduate and Associate degree Physiotherapy Departments organizations and academic/research groups in Turkiye.

Statistical Analysis

We analyzed data using the SPSS 22.0 program (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). Initially, we reported descriptive statistics as counts, proportions, or percentages. We used cross-tabulations to analyze relationships between the professions of the participant and their educational backgrounds for EMG training. If the expected values for any cell in the cross-tabulation table were less than 5 and the sample size was small, Fisher's exact test was used to analyze the relationship between the variables due to the small expected cell frequencies (less than 5) and the small sample size. We then performed chi-square tests on nominal explanatory variables. The significance level was set as p and displayed response frequencies, means, and p values of the survey items in tabular and graphic formats.

RESULTS

Only completed questionnaires were analyzed. In total, we correctly received 104 surveys. The details of the participants' characteristics are given in Table 1.

Fig.1 shows the response rates of the participants in which areas they used sEMG. Each participant could choose one or more options from the list and answer open questions.

The response rates of participants for the questions are shown in Table 2, which are relevant to the current level of using sEMG, the barriers, and the facilitators for using sEMG.

Table 1. Characteristics of The Participants (Total Number of Participants=104)

Variable	Neurology& Clin Neurophysiol MDs N (%)	PM&R MDs N (%)	PTs N (%)	Non-clinicians N (%)	Total N (%
Gender					
Male	7 (6.7)	18 (17.3)	10 (9.6)	18 (17.3)	53 (50.9)
Female	5 (4.8)	29 (27.9)	16 (15.4)	1 (1.0)	51 (49.1)
Age					
20-30 years	1 (1.0)	8 (7.7)	11 (10.6)	1 (1.0)	21 (19.5)
31-40 years	5(4.8)	18 (17.3)	8 (7.7)	8 (7.7)	39 (37.8)
41-50 years	3 (2.9)	15 (14.4)	7 (6.7)	6(5.8)	31 (30.0)
> 51 years	3 (2.9)	6 (5.8)	0 (0.0)	4 (3.8)	13 (12.7)
Education					
Bachelor degree	0 (0.0)	1 (1.0)	12 (11.5)	1 (1.0)	14 (13.5)
Master's degree	0 (0.0)	5 (4.8)	6 (5.8)	3 (2.9)	14 (13.5)
Doctorate / Specialization degree	12 (11.5)	41 (39.4)	8 (7.7)	15 (14.4)	76 (73.0)
EMG Training					
None	2 (1.9)	17 (16.3)	14 (13.5)	12 (11.5)	45 (43.3)
nEMG course	8(7.7)	28 (26.9)	0 (0.0)	6 (5.8)	42 (40.4)
sEMG and nEMG course	0 (0.0)	2 (1.9)	3 (2.9)	0 (0.0)	5 (4.8)
Other	2 (1.9)	0 (0.0)	9 (75.0)	1 (1.0)	12 (11.5)
Working Condition					
Public (State)	4 (3.8)	13 (12.5)	5 (4.8)	4 (3.8)	26 (25.0)
Private	1 (1.0)	7 (28.0)	14 (56.0)	3 (2.9)	25 (24.0)
T&R Hospital	0 (0.0)	5 (4.8)	0 (0.0)	1 (1.0)	6 (5.8)
University	7 (5.8)	21 (20.2)	7 (6.7)	12 (11.5)	47 (45.2)

MDs=medical doctors, PM&R=physical medicine and rehabilitation, PTs=physiotherapists, Clin. Neurophy= clinical neurophysiology, T&R= training & researching, nEMG=needle EMG, N= number , %=percentage

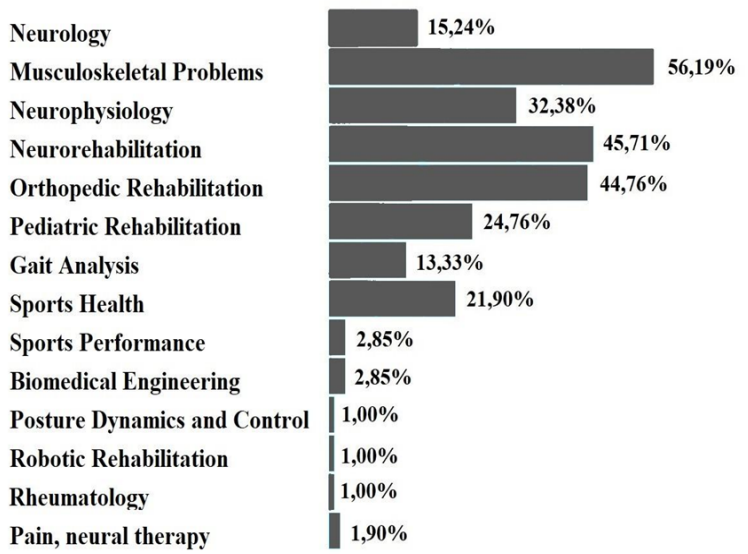

Fig. 1 Response rates of the participants in which areas they used sEMG (each participant chose one or more than one option.)

We mainly found overall perceptions of barriers as a lack of knowledge and experience about sEMG, data analysis, and interpretation of EMG signals. Table 3 shows the relationship between the participants' working fields and the variables "using sEMG in routine", "using sEMG for diagnostic", "using sEMG for treatment", and "using sEMG for research.

In Table 3, we found statistically significant differences between professions and using sEMG in their routine practice (p=0.001). Except for participants whose expertise is in neurology and neurophysiology, many of the participants reported they did not use sEMG in routine (Table 2). When comparing the difference between professions and purposes of using sEMG, we also found statistically significant differences for the diagnosis (p=0.002) and research (p=0.004) but no differences for treatment (p=0.103). Table 4 shows a cross-tabulation of participants' educational backgrounds on sEMG and those variables.

When comparing educational backgrounds and the barriers, we found statistically significant differences between the participants who did take the sEMG course and participants who did not (p=0.009). We also found a statistically significant difference between the variable participant's working fields and the variable "using sEMG in routine" (p0.05).

Table 2. Questions and Response Rates About The Current Level of Using sEMG, The Barriers Limiting The Use of sEMG, and The Facilitating and Encouraging Factors for The Use of sEMG

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	N (%)	N (%)	N (%)	N (%)	N (%)
The current use of sEMG					
I used sEMG during my undergraduate / graduate/ specialty or workplace training	32 (30.5)	13 (12.4)	8 (7.6)	17 (16.2)	34 (33.3)
I qualify for the sEMG application	39 (37.1)	16 (15.2)	12 (11.4)	18 (17.1)	19 (19.0)
I use the sEMG in my routine ractice	56 (54.3)	11 (10.5)	10 (9.5)	13 (12.4)	14 (13.3)
I use the sEMG for diagnostic	52 (49.5)	7 (7.6)	7 (7.6)	20 (19.0)	18 (17.1)
I use the sEMG for treatment.	57 (55.2)	16 (15.2)	13 (12.4)	11 (10.5)	7 (6.7)
I use the sEMG for prognostics	53 (50.5)	9 (9.5)	17 (16.2)	12 (11.4)	13 (12.4)
I use the sEMG for research.	46 (44.8)	9 (8.6)	5 (4.8)	20 (19.0)	24 (22.9)
The barriers limiting the use of sEMG					
Using sEMG is time-consuming	51 (48.6)	30 (29.5)	13 (12.4)	6 (5.7)	4 (3.8)
The most important limitation is the absence of sEMG device	13 (13.3)	8 (7.6)	28 (26.7)	28 (26.7)	27 (25.7)
The most important limitation is the high cost of the sEMG device and its components.	6 (5.7)	10 (9.5)	36 (34.3)	24 (22.9)	28 (26.7)
The most important limitation is a lack of knowledge and experience using sEMG	8 (7.6)	10 (10.5)	20 (19.0)	25 (23.8)	41 (39.0)
The most important limitation is a lack of knowledge of data analysis	9 (8.6)	17 (16.2)	31 (29.5)	30 (28.6)	18 (17.1)
The department or institution management does not support the use of sEMG	25 (23.8)	17 (17.1)	30 (28.6)	11 (10.5)	21 (20.0)
The facilitating and encouraging factors for the use of sEMG					
sEMG is useful in diagnosis.	13 (12.4)	3 (2.9)	20 (19.0)	27 (25.7)	41 (39.0)
sEMG is useful in treatment.	14 (13.3)	6 (5.7)	35 (33.3)	30 (28.6)	19 (18.1)
sEMG methods are reliable.	7 (7.6%)	4 (3.8)	22 (21.0)	41 (39.0)	30 (28.6)
sEMG methods are reproducible.	5 (4.8)	4 (3.8)	11 (10.5)	39 (37.1)	45 (42.9)
I will use sEMG much more in the future.	7 (7.6)	4 (3.8)	17 (16.2)	29 (27.6)	47 (44.8)
The experience in needle EMG is facilitating in sEMG.	4 (3.8)	4 (3.8)	15 (14.3)	32 (30.5)	50 (47.6)
Using sEMG in diagnosis and treatment increases patient satisfaction.	3 (2.9)	6 (5.7)	33 (31.4)	26 (25.7)	36 (34.3)

N= number

Table 3. The Relationship Between Participants' Expertise Fields and The Response to The Current Status and Purpose of Using sEMG

Working Field	Strongly Disagree N(%)	Disagree N(%)	Neutral N(%)	Agree N(%)	Strongly Agree N(%)	Chi-square test p
Question: I use sEMG in my routine practice						
Neurology & Clin Neurophysiol MDs	3 (25.0)	1 (8.3)	1 (8.3)	6 (50.0)	1 (8.3)	**0.001*** [a]
PM&R MDs	22 (46.8)	8 (17.0)	5 (10.6)	5 (10.6)	7 (14.)	
PTs	23 (88.5)	0 (0.0)	1 (3.8)	1 (3.8)	1 (3.8)	
Non-clinicians	8 (42.1)	2 (10.5)	3 (15.8)	1 (5.3)	5 (26.3)	
Total	56 (53.8)	11 (10.6)	10 (9.6)	13 (12.5)	14 (13.5)	
Question: I use sEMG for diagnostic purposes						
Neurology & Clin Neurophysiol MDs	3 (25.)	1 (8.3)	1 (8.3)	4 (33.3)	3 (25.0)	**0.002*** [a]
PM&R MDs	16 (34.0)	5 (10.6)	2 (4.3)	12 (25.5)	2 (25.5)	
PTs	22 (84.6)	1 (3.8)	1 (3.8)	1 (3.8)	1 (3.8)	
Total	52 (50.0)	7 (6.7)	7 (6.7)	20 (19.2)	18 (17.3)	
Question: I use the sEMG for treatment purposes						
Neurology & Clin Neurophysiol MDs	8 (66.7)	4 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0.103 [a]
PM&R MDs	20 (42.6)	10 (21.3)	6 (12.8)	7 (14.9)	4 (8.5)	
PTs	18 (69.2)	2 (7.7)	2 (7.7)	2 (7.7)	2 (7.7)	
Total	57 (54.8)	16 (15.4)	13 (12.5)	11 (10.6)	7 (6.7)	
Question: I use sEMG for research purposes						
Neurology & Clin Neurophysiol MDs	3 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	**0.004*** [a]
PM&R MDs	21 (44.7)	7 (14.9)	1 (2.1)	10 (21.3)	8 (17.0)	
PTs	17 (65.4)	1 (3.8)	3 (11.5)	2 (7.7)	3 (11.5)	
Non-clinicians	5 (26.3)	1 (5.3)	1 (5.3)	2 (10.5)	10 (52.6)	
Total	46 (44.2)	9 (8.7)	5 (4.8)	20 (19.2)	24 (23.1)	

MDs=medical doctors, PM&R=physical medicine and rehabilitation, PTs=physiotherapists, Clin. Neurophysiol= clinical neurophysiology; N= number, %=percentage within each working field, p= statistically significant level, * = $p < 0.05$ Fisher's exact test was used to analyze the relationship between the variables due to the small expected cell frequencies (less than 5)

DISCUSSION

Current Level of Using sEMG

Our study revealed that sEMG is underutilized in clinical practice, particularly for prognosis and treatment, with significant differences in usage among various professional groups. In Table 3. Furthermore, most of the neurology, clinical neurophysiology, and PM&R MDs used sEMG for diagnosis, but PTs and non-clinicians did not. Besides, while most non-clinicians agreed with the research, clinicians and PTs did not. This finding aligns with previous studies indicating that sEMG is more relevant for research than clinical practice (8,9). In other words, sEMG is commonly used for research purposes rather than for routine clinical practice. Most PTs surprisingly agreed on using sEMG neither for treatment nor research. One reason for these results can be relevant to the position of PTs. In Turkiye, PTs generally works in cooperation with MDs who are specialist in the diagnosis of diseases and the other members of the rehabilitation team. They inform the relevant specialist physician about the course of the treatment. PTs showed the lowest percentage of using sEMG in their routine clinical practice (agree=3,8% and strongly agree=3,8%) when comparing the other practitioners. In terms of perception and attitudes, participants might have probably believed that sEMG has been a part of the competence fields of neurology rather than physiotherapy or rehabilitation. Previous studies reported compatible results (7-9). This result may be the case in many other countries, and this point

Table 4. Cross-tabulation of Participants' Educational Backgrounds on sEMG and The Questions Relevant to The Barriers Limiting The Use of sEMG and The Facilitators

sEMG Training	Strongly Disagree N (%)	Disagree N (%)	Neutral N (%)	Agree N (%)	Strongly Agree N (%)	Chi-square test p
Question: The most important limitation in using sEMG is the lack of knowledge and experience						
Yes	2 (4.3)	7 (15.2)	8 (17.4)	17 (37.0)	12 (26.1)	
No	6 (10.3)	3 (5.2)	12 (20.7)	8 (13.8)	29 (50.0)	**0.009*[a]**
Total	8 (7.7)	10 (9.6)	20 (19.2)	25 (24.0)	41 (39.4)	
Question: Using sEMG is time-consuming						
Yes	22 (47.8)	15 (32.6)	4 (8.7)	4 (8.7)	1 (2.2)	
No	29 (50.0)	15 (25.9)	9 (15.5)	2 (3.4)	3 (5.2)	0.554[a]
Total	51 (49.0)	30 (28.8)	13 (12.5)	6 (5.8)	4 (3.8)	
Question: The most important limitation in using sEMG is the lack of knowledge and experience in data analysis						
Yes	3 (6.5)	8 (17.4)	14 (30.4)	16 (34.8)	5 (10.9)	
No	5 (8.6)	9 (15.5)	17 (29.3)	14 (24.1)	13 (22.4)	0.529[a]
Total	8 (7.7)	17 (16.3)	31 (29.8)	30 (28.8)	18 (17.3)	
Question: sEMG will be used much more in the future						
Yes	4 (8.7)	3 (6.5)	8 (17.4)	12 (26.1)	19 (41.3)	
No	3 (5.2)	1 (1.7)	9 (15.5)	17 (29.3)	28 (48.3)	0.680 [a]
Total	7 (6.7)	4 (3.8)	17 (16.3)	29 (27.9)	47 (45.2)	
Question: Getting experience in needle EMG is facilitating sEMG						
Yes	1 (2.2)	2 (4.3)	3 (6.5)	18 (39.1)	22 (47.8)	
No	3 (5.2)	1 (1.7)	12 (20.7)	14 (24.1)	28 (48.3)	0.134 [a]
Total	4 (3.8)	3 (2.9)	15 (14.4)	32 (30.8)	50 (48.1)	
Question: Using sEMG in diagnosis and treatment increases patient satisfaction						
Yes	0 (0.0)	3 (6.5)	10 (21.7)	13 (28.3)	20 (43.5)	
No	3 (5.2)	3 (5.2)	23 (39.7)	13 (22.4)	16 (27.6)	0.122 [a]
Total	3 (2.9)	6 (5.8)	33 (31.7)	26 (25.0)	36 (34.6)	

N= number, %=percentage within each working field, p= statistically significant level, * = p < 0.05 Fisher's exact test was used to analyze the relationship between the variables due to the small expected cell frequencies (less than 5), Yes= participants who took sEMG course, No: participants who did not take sEMG course

should be considered (8,9). PTs probably don't perform gait or movement analysis, and therefore, they do not need sEMG. Whereas, PTs are mainly expected to use a wide range of assessments, including aerobic capacity/endurance, anthropometric measurements, cognitive status, circulation, respiration, cranial and peripheral nerve integrity, gait, balance and locomotion, skin integrity, joint integrity and mobility, motor function, muscle performance, neuro-motor development and supportive device, orthosis, prosthesis, protective and supportive device, pain, posture, reflexes, range of motion, and sensory integrity assessments. This may be because the lack of knowledge and awareness of PTs during educational and clinical experiences leads to a limited translational effort from research outcomes to clinical practice (3,11). Gofredo et al. reported that the insufficient knowledge of sEMG among PTs was the reason for the limited diffusion of sEMG in the rehabilitation hospital (8). Our results also showed that PTs declared a great interest and a very positive approach to rehabilitation technologies but they didn't attend either for a longer course of studies (e.g. 4 years in the USA, 3 years in most Europen Countries) or a clinical doctorate (as in the USA) or Ph.D. (as in many countries, including the USA). This finding may be addressed as contradictory behavior. The limited use among PTs and clinicians suggests a need for enhanced training and education in sEMG applications. Therefore, in undergraduate and graduate education programs of PTs, courses on sEMG should be supported because the test and measurement skills are an indispensable part of

the EBP approach (12). We present two perspectives to find possible solutions. First is the transformation of attitudes and perceptions related to the use of sEMG among clinicians. Second, is translating advances in sEMG into medical education curriculums and clinical settings. Although sEMG has many applications in the treatment and rehabilitation of patients (2,13,14), our results also revealed that there was no sufficient translation into clinical practice for treatment. sEMG has not been included in the core medical education programs although it has been used in a few centers among the specialist training programs while routine needle EMG has been included in specialization training programs (neurology, clinical neurophysiology, and PM&R) in Turkiye. Therefore, interdisciplinary collaboration and hybrid educational models can give effective solutions to meet the demands and increase clinical acceptance among the clinician community (15).

Barriers Limiting to Use of sEMG

In the present study, the main barriers identified were a lack of knowledge and experience with sEMG, high costs of devices, and limited institutional support. These barriers are consistent with those reported in the literature and highlight the need for targeted educational interventions and investment in affordable sEMG technology (3-5,7, 15-17). However, the majority of participants reported that using sEMG did not cause time-consuming work in our study contrary to previous studies (7,9). Regarding financial issues, the high cost of EMG devices could be an obstacle to the widespread use of sEMG due to the limited market and the high exchange rate in some countries such as Turkiye. Furthermore, health insurance does not pay for evaluations made with sEMG in many countries. This situation stands as a barrier to functional evaluation and measurements of sEMG. We expect that new technical and technological advances in sEMG will contribute to low-cost devices and software. Concerning organization obstacles, our results showed that approximately one-third of respondents (30,5%) stated that the management department did not provide sEMG courses or devices. It may relate the reason for this to the percentage (26.7%) of participants who work in the private sector. The lower use of sEMG in private clinics may be due to not considering it as a mandatory process in the assessment protocol. In addition, sEMG examinations (as in gait analysis) may interfere with efficient patient flow and insurance services. In Turkiye, it is a fact that private institutions focus on the treatment rather than the assessments of the outcomes. This may be because the clinical research studies are especially supported in university and education&research hospitals in which approximately half of the participants worked. The organizations should support clinicians with special training, sufficient administrative support, and adequate devices for widespread clinical acceptance.

We also found statistical differences relevant to educational backgrounds and the lack of knowledge and experience using sEMG systems. Our results showed that educational backgrounds about sEMG make adaptation easier for clinicians in their routine clinical practice. While clinicians receive education in other diagnostic modalities like ECG and EEG, sEMG training can be often limited or not included in their formal education curriculum. The absence of dedicated training programs could lead to a knowledge gap and a lack of confidence in integrating sEMG into clinical practice. Integrating sEMG education and training into the formal curriculum for healthcare professionals, such as physicians, physical therapists, and occupational therapists, could be essential. Comprehensive training initiatives encompassing dedicated programs, workshops, and continuing education courses can enhance clinicians' familiarity with sEMG, covering topics such as electrode placement, signal analysis, interpretation, and clinical applications. Hands-on practical training should be emphasized to improve clinicians' confidence and proficiency in utilizing sEMG. Therefore, multidisciplinary bachelor's and master's programs are needed because advances in medical technology need new professional skills with medical and technical knowledge that bridge the gap between innovative technology and clinical practice. Recently, these types of new hybrid models have been applied in Dutch Education, by existing technology in innovative ways to optimize diagnostic and treatment methods. For example, The Clinical Technology degree program comprises technology courses and medical courses through a collaborative partnership between the Delft Uni-

versity of Technology and the Techmed Centre of Twente University in Dutch (18,19). This type of hybrid program can provide students to analyze the human body and diseases from the perspective of an engineer and learn to work with complex technologies through collaboration with industry and hospitals on the development of new solutions for healthcare. Promoting collaboration between researchers, clinicians, and educators including clinical and engineering can bridge the gap between research findings and clinical practice. Researchers can work closely with clinicians to identify and address specific clinical needs, develop relevant research studies, and provide evidence for the clinical utility of sEMG. Clinicians can contribute their expertise in patient assessment and treatment planning, ensuring that research outcomes align with real-world clinical scenarios. Educators can play a crucial role in incorporating sEMG into medical and allied health curricula, promoting interdisciplinary approaches that encourage integration and utilization of sEMG in clinical practice. Efforts should be made to make sEMG technology more accessible and affordable. This includes developing cost-effective sEMG systems and ensuring their availability in different healthcare settings. Collaborations between industry and academia can drive technological advancements, making sEMG devices more user-friendly, portable, and affordable for clinicians.

In addition, the EBP approach in education and training should be planned in line with national and international accreditation criteria because EBP is an important approach for students to access, evaluate, and apply research evidence in clinical decision-making (12). Conducting robust clinical studies to generate evidence for the clinical utility and effectiveness of sEMG is vital. Well-designed research studies, including randomized controlled trials and systematic reviews, can provide high-quality evidence supporting the use of sEMG in specific clinical applications. This evidence could be disseminated to the medical community through peer-reviewed publications and conferences to increase awareness and confidence in sEMG among clinicians One major barrier was also the correct analyses and interpretation of sEMG signals because there is a lack of specialized courses on sEMG in the curriculums. Interpreting sEMG signals requires expertise and experience. The complexity of differentiating between muscle activation patterns, understanding the underlying neuromuscular mechanisms, and distinguishing between normal and abnormal muscle activity poses challenges for clinicians. The interpretation of sEMG data may require specialized knowledge, which can act as a deterrent to its widespread use in clinical settings. To promote this point, new teaching content and materials that can meet the knowledge and skill needs of potential practitioners in sEMG can be adopted (20,21). For example, teaching initiatives (a series of tutorials for clinicians) organized by ISEK can be given as one of the good examples (6, 22). These tutorials and webinars have been oriented to non-engineers to provide technical backgrounds on some fundamental topics in sEMG such as not only anatomy from the perspective of medicine but also the body from the perspective of the laws of biomechanics or fundamentals of electrophysiological signals. Thus, novel hybrid curriculums for clinicians and PTs can provide a comprehensive overview of the technical aspects of recording and analyzing sEMG signals. However, integrating the technological and methodological advances into the existing sEMG systems cannot be simultaneous (9). Therefore, further continuous efforts would be needed to develop courses on novel methods for clinicians. The user-friendly software and hardware for analysis and interpretation of sEMG signals could also play a key facilitator role in helping clinicians to provide use of sEMG in clinics throughout the practical experience. Providing ongoing support and resources to clinicians during the implementation phase is crucial. This can include mentorship programs, online forums, and dedicated support networks where clinicians can seek guidance, share experiences, and learn from experts in the field. Clinicians should also have access to comprehensive software tools for data analysis and interpretation to facilitate the integration of sEMG into their clinical workflow.

Facilitators and Benefits of Using sEMG

In general, our results indicated that participants recognized the potential benefits of sEMG in diagnosis and treatment, including increased patient satisfaction and improved clinical outcomes. The participants had a common perception of the

clinical potential of sEMG to provide reliable and reproducible application in clinical practice, similar to previous studies (8,9,14). These perceptions suggest that with adequate training and resources, the clinical adoption of sEMG could be significantly enhanced. Participants may have expected that the potential benefits of sEMG could increase patients' satisfaction and improve tracking of the patient's progress, specific quantitative evidence, and clinical information. Of course, the knowledge and experience about sEMG may also affect aspects related to patient management. Giving information to the patients about the advantages of sEMG may decrease stress and may positively change patients' satisfaction. The patient information on sEMG could be very important to improve patient satisfaction and EBP-based health care (23). In Table 4, all participants with different educational backgrounds for sEMG had positive beliefs and attitudes towards the use of sEMG. Our results show that participants widely agreed on the fact that experiences with needle EMG can be a facilitator for sEMG. By implementing the strategies abovementioned such as comprehensive training and education, interdisciplinary collaboration, technology accessibility and affordability, and providing ongoing support and resources, the widespread use of sEMG in clinical practice can be facilitated. These strategies can also promote the integration of sEMG as a valuable tool for diagnostic, treatment, and monitoring purposes in various clinical settings.

Limitations

This study had some potential limitations. Although this study attempted to include a variety of participants from diverse professional settings, these data did not represent perceptions across the wider potential practitioners of sEMG fields in Turkiye because potential participants were less willing to respond to such a survey study. This may be considered as nonresponse bias, which is related to the decision to take part in our study and the differences between those who cooperated and those from whom data were not gathered. Similarly, the present study had a small sample size for analysis with cross tables, which did not represent any "working field" as a "national" representation. We, therefore, used the chi-square test to a limited extent to investigate how the correlation of results differs according to participant's expertise fields and being sEMG training before.

Conclusion : Our study provides valuable insights into the current utilization, barriers, and facilitators of sEMG among clinicians in Türkiye. Despite positive perceptions, significant barriers limit its widespread adoption. Overcoming these challenges through educational and technological advancements is essential for enhancing its clinical utility. We recommend integrating sEMG training into medical and allied health curricula, developing multidisciplinary educational programs, and fostering collaborative research. Additionally, hybrid education models, such as the Dutch model, are necessary to equip professionals with both medical and technical expertise.

The statement of conflict of interest : The authors declare that there are no conflicts of interest

Author Contributions: Concept: VA; Design Planning the methods to generate hypothesis: VA; Supervision: MZ, HU; Data Collection and/or Processing: VA, MZ, AK, HU, ED; Data Analysis and/or Interpretation: VA, HT; Literature Search: VA, MZ, AK; Writing Manuscript: VA, MZ, AK, HT, ED.

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Appendix

CHERRIES Check List

Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Checklist Item	Explanation	Page Number
Describe survey design	Describe the target population and sample frame. Is the sample a convenience sample? (In "open" surveys this is most likely.)	Page=3, Method Section
IRB approval	Mention whether the study has been approved by an IRB.	Page=3, Method Section
Informed consent	Describe the informed consent process. Where were the participants told the length of time of the survey, which data were stored and where and for how long, who the investigator was, and the purpose of the study?	Page=3, Method Section
Data protection	If any personal information was collected or stored, describe what mechanisms were used to protect unauthorized access.	Page=4, Method Section: Guaranteed with user name and password of the responsible researchers' login to Google Form
Development and testing	State how the survey was developed, including whether the usability and technical functionality of the electronic questionnaire had been tested before fielding the questionnaire.	Page=3, Method Section.
Open survey versus closed survey	An "open survey" is a survey open for each visitor of a site, while a closed survey is only open to a sample that the investigator knows (password-protected survey).	Open survey
Contact mode	Indicate whether or not the initial contact with the potential participants was made on the Internet. (Investigators may also send out questionnaires by mail and allow for Web-based data entry.)	Page=3 and 4, Method Section: The potential participants were contacted with mail list and web-based data. Questionnaires were sent out by mail
Advertising the survey	How/where was the survey announced or advertised? Some examples are offline media (newspapers), or online (mailing lists – If yes, which ones?) or banner ads (Where were these banner ads posted and what did they look like?). It is important to know the wording of the announcement as it will heavily influence who chooses to participate. Ideally, the survey announcement should be published as an appendix.	Page=3 and 4, Method section: The Survey was announced through online mailing lists.
Web/E-mail	State the type of e-survey (eg, one posted on a Web site, or one sent out through e-mail). If it is an e-mail survey, were the responses entered manually into a database, or was there an automatic method for capturing responses?	Page=3, Methods section: a web-based survey
Context	Describe the Web site (for mailing list/newsgroup) on which the survey was posted. What is the Website about, who is visiting it, what are visitors normally looking for? Discuss to what degree the content of the Web site could pre-select the sample or influence the results. For example, a survey about vaccination on an anti-immunization Web site will have different results from a Web survey conducted on a government Web site	Page=3, Method Section: the online survey was developed using the Google Form.
Mandatory/voluntary	Was it a mandatory survey to be filled in by every visitor who wanted to enter the Web site, or was it a voluntary survey?	Page=3, Method Section: It was voluntary.
Incentives	Were any incentives offered (eg, monetary, prizes, or non-monetary incentives such as an offer to provide the survey results)?	None
Time/Date	In what timeframe were the data collected?	Page=4, Methods section: 14 weeks
Randomization of items or questionnaires	To prevent biases items can be randomized or alternated.	No
Adaptive questioning	Use adaptive questioning (certain items, or only conditionally displayed based on responses to other items) to reduce the number and complexity of the questions.	Methods and Results section: yes
Number of Items	What was the number of questionnaire items per page? The number of items is an important factor in the completion rate.	46(maximum)
Number of screens (pages)	Over how many pages was the questionnaire distributed? The number of items is an important factor in the completion rate.	4 (maximum)
Completeness check	It is technically possible to do consistency or completeness checks before the questionnaire is submitted. Was this done, and if "yes", how (usually JAVAScript)? An alternative is to check for completeness after the questionnaire has been submitted (and highlight mandatory items). If this has been done, it should be reported. All items should provide a non-response option such as "not applicable" or "rather not say", and the selection of one response option should be enforced.	Answers to all questions were voluntary, and we included no completeness checks during the survey.

Review step	State whether respondents were able to review and change their answers (e.g., through a Back button or a Review step which displays a summary of the responses and asks the respondents if they are correct).	"Go back" and "proceed/next" buttons were used so that participants could switch between pages and change their answers
Unique site visitor	If you provide view rates or participation rates, you need to define how you determine a unique visitor. There are different techniques available, based on IP addresses cookies, or both.	Each participant was able to fill out the survey with their user name and individual mail address. Only participants completing all sections were identified as respondents. We therefore calculated the participation rate
View rate (Ratio of unique survey visitors/unique site visitors)	Requires counting unique visitors to the first page of the survey, divided by the number of unique site visitors (not page views!). It is not unusual to have view rates of less than 0.1 % if the survey is voluntary.	
Participation rate (Ratio of unique visitors who agreed to participate/unique first survey page visitors)	Count the unique number of people who filled in the first survey page (or agreed to participate, for example by checking a checkbox), divided by visitors who visit the first page of the survey (or the informed consent page, if present). This can also be called the "recruitment" rate.	
Completion rate (Ratio of users who finished the survey/users who agreed to participate)	The number of people submitting the last questionnaire page is divided by the number of people who agreed to participate (or submitted the first survey page). This is only relevant if there is a separate "informed consent" page or if the survey goes over several pages. This is a measure of attrition. Note that "completion" can involve leaving questionnaire items blank. This is not a measure of how completely questionnaires were filled in. (If you need a measure for this, use the word "completeness rate".)	Page=4, Method and Results section:
Cookies used	Indicate whether cookies were used to assign a unique user identifier to each client computer. If so, mention the page on which the cookie was set and read, and how long the cookie was valid. Were duplicate entries avoided by preventing users access to the survey twice; or were duplicate database entries having the same user ID eliminated before analysis? In the latter case, which entries were kept for analysis (e.g., the first entry or the most recent)?	A total of 107 participants of 332 potential users sent invitations and agreed to respond to the survey. And total participants included in the present study.
IP check	Indicate whether the IP address of the client computer was used to identify potential duplicate entries from the same user. If so, mention the period for which no two entries from the same IP address were allowed (e.g., 24 hours). Were duplicate entries avoided by preventing users with the same IP address access to the survey twice; or were duplicate database entries having the same IP address within a given period eliminated before analysis? If the latter, which entries were kept for analysis (e.g., the first entry or the most recent)?	Page 4, Method Section: To avoid receiving multiple responses from the same respondent, only one response was allowed per email address
Log file analysis	Indicate whether other techniques to analyze the log file for identification of multiple entries were used. If so, please describe.	None
Registration	In "closed" (non-open) surveys, users need to log in first and it is easier to prevent duplicate entries from the same user. Describe how this was done. For example, was the survey never displayed a second time once the user had filled it in, or was the username stored together with the survey results and later eliminated? If the latter, which entries were kept for analysis (e.g., the first entry or the most recent)?	No login was required.
Handling of incomplete questionnaires	Were only completed questionnaires analyzed? Were questionnaires that terminated early (where, for example, users did not go through all questionnaire pages) also analyzed?	Page 4, Results Section: Only completed questionnaires were analyzed.
Questionnaires submitted with an atypical timestamp	Some investigators may measure the time people needed to fill in a questionnaire and exclude questionnaires that were submitted too soon. Specify the timeframe that was used as a cut-off point, and describe how this point was determined.	
Statistical correction	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for the non-representative sample; if so, please describe the methods.	No statistical correction was implemented

This checklist has been modified from Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res. 2004 Sep 29;6(3):e34 (erratum in J Med Internet Res. 2012; 14(1): e8.). Article available at https://www.jmir.org/2004/3/e34/; erratum available https://www.jmir.org/2012/1/e8/. Copyright ©Gunther Eysenbach. Originally published in the Journal of Medical Internet Research, 29.9.2004 and 04.01.2012.

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Burak KARAHAN, PT, MSc[1]
Hilal ASLAN, PT, MSc*[2]
Emre UYSAL, PT, MsC[3]
Rabia Tuğba TEKİN, PT, PhD.[4]

1 *Ankara Yıldırım Beyazıt University, Institute of Health Sciences, Ankara, Department of Physiotherapy and Rehabilitation, 06010, Turkey*
2 *Ankara Yıldırım Beyazıt University, Faculty of Health Science, Physiotherapy and Rehabilitation, Ankara, 06760, Turkey.*
3 *Ege University, Faculty of Health Science, Physiotherapy and Rehabilitation, 35575, İzmir, Turkey.*
4 *Hacettepe University, Faculty of Physiotherapy and Rehabilitation, 06760, Ankara, Turkey.*

Correspondence (İletişim):

Hilal ASLAN, PT, MSc.
Ankara Yıldırım Beyazıt University, Faculty of Health Science, Physiotherapy and Rehabilitation, Ankara, Turkey. hilalaslan@aybu.edu.tr, ORCID: 0000-0002-6944-0595

Burak KARAHAN
E-mail: burakkarahan10@gmail.com
ORCID: 0000-0003-1404-3071

Emre UYSAL
E-mail: emreuysal-95@hotmail.com
ORCID: 0000-0002-7704-2773

Rabia Tuğba TEKİN
E-mail: rtugbakilic@gmail.com
ORCID: 0000-0002-3276-5097

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THE RELATIONSHIP BETWEEN HEART RATE VARIABILITY AND ATHLETIC PERFORMANCE IN BASKETBALL PLAYERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: For basketball players, improving athletic performance is one of the main keys to success and the autonomic nervous system can also affect athletic performance. Heart rate variability (HRV) can be associated with sportive performance as a marker of the autonomic nervous system. Our study was planned to investigate the relationship between HRV method and basketball-specific sportive performance.

Methods: The study was conducted with 20 male basketball players. Vertical jump and seated chest pass test were used to evaluate strength, T agility test was used to evaluate agility, lower and upper extremity Y balance tests were used to evaluate balance and Johnson Basketball Test Battery was used to evaluate basketball specific performances. Autonomic nervous system was evaluated by heart rate variability. The relationships between HRV results and performance results were analyzed.

Results: Correlations were found at various levels between the vertical jump and seated chest pass tests and some parameters of the HRV between the T agility test and some parameters of the HRV, and between the Johnson Basketball Test Battery and some parameters of the HRV ($p<0.05$). No statistically significant correlation was found between upper and lower extremity Y balance tests and HRV parameters ($p>0.05$).

Conclusion: Since the results of our study show that HRV may be related to performance, it is suggested that measuring HRV assessments at different periods during the whole season may be useful for athlete evaluations. However, it is thought that more detailed studies are needed in this field for clearer information.

Keywords: Autonomic nervous system, Basketball, Heart rate variability, Performance.

BASKETBOLCULARDA KALP HIZI DEĞİŞKENLİĞİ VE SPORTİF PERFORMANS ARASINDAKİ İLİŞKİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Basketbol oyuncuları için atletik performansı artırmak başarının ana anahtarlarından biridir ve otonom sinir sistemi de atletik performansı etkileyebilir. Kalp hızı değişkenliği (KHD), otonom sinir sisteminin bir belirteci olarak sportif performans ile ilişkilendirilebilir. Çalışmamız kalp hızı değişkenliği yöntemi ile basketbola özgü sportif performans arasındaki ilişkiyi araştırmak üzere planlanmıştır.

Yöntem: Çalışma 20 erkek basketbolcu ile gerçekleştirildi. Kuvveti değerlendirmek için dikey sıçrama ve otururak göğüs pas testi, çevikliği değerlendirmek için T çeviklik testi, dengeyi değerlendirmek için alt ve üst ekstremite Y denge testleri ve basketbola özgü performansları değerlendirmek için Johnson Basketbol Test Bataryası kullanıldı. Otonom sinir sistemi kalp atım hızı değişkenliği ile değerlendirilmiştir. KHD sonuçları ile performans sonuçları arasındaki ilişkiler analiz edildi.

Sonuçlar: Dikey sıçrama ve oturarak göğüs pas testleri ile KHD'nin bazı parametreleri arasında, T çeviklik testi ile KHD'nin bazı parametreleri arasında ve Johnson Basketbol Test Bataryası ile KHD'nin bazı parametreleri arasında çeşitli düzeylerde korelasyonlar bulundu ($p<0,05$). Üst ve alt ekstremite Y denge testleri ile KHD parametreleri arasında istatistiksel olarak anlamlı bir korelasyon bulunmadı ($p>0,05$).

Tartışma: Çalışmamızın sonuçları KHD'nin performansla ilişkili olabileceğini gösterdiğinden, KHD değerlendirmelerinin tüm sezon boyunca farklı dönemlerde ölçülmesinin sporcu değerlendirmeleri için yararlı olabileceği önerilmektedir. Ancak daha net bilgiler için bu alanda daha detaylı çalışmalara ihtiyaç olduğu düşünülmektedir.

Anahtar kelimeler: Basketbol, Kalp atım hızı değişkenliği, Otonom sinir sistemi, Performans.

INTRODUCTION

Defined as "a complex product of cognitive information about the current situation and past events and a player's ability to produce the required sport skill(s)" (1), sportive performance is considered as one of the main key factors to success for athletes (2). The way to improve sportive performance depends on physical fitness parameters. While the physical fitness parameters related to health are mostly related to daily activities, the parameters related to performance form the basis of the skills that need to be met in sports (3).

Heart rate variability (HRV) is a non-invasive measure of the balance between sympathetic and parasympathetic activity of the autonomic nervous system in physiological and pathological conditions and reflects the time variability between consecutive heart beats (4, 5). It can be observed as the variability of the interval of the beats of the heart called N-N (normal beat to normal beat) or RR (R wave to R wave) during the electrocardiogram. It is considered a quantitative marker to assess adequate cardiac regulation by the autonomic nervous system in response to both physical and psychological stimuli (6).

HRV levels may differ between exercise and resting states, which is closely related to the modulatory effects of exercise on the autonomic nervous system. Studies have demonstrated that HRV parameters show a negative relationship with increasing exercise intensity and that sympathetic system dominance in sympathovagal balance increases with the effect of high physical stress during exercise (7, 8). In addition, the fact that HRV is regulated by the autonomic nervous system indicates that HRV is a reflector of neuro-cardiac functions, and HRV studies conducted after high-intensity training may be an indicator to determine training and recovery strategies for athletes (10). In this context, HRV is also important for clinical use because it shows physiological changes in autonomic functions (11).

Basketball is a team sport that includes important physical fitness parameters such as endurance, flexibility, speed, power, strength, coordination, agility, and game-specific skills (12). The game is a high-intensity sport in which the tempo of the game decreases and increases frequently and includes runs, sprints, jumps (rebounds, blocks, throws, etc.), and movements with the ball (13, 14), which highlight the characteristics of athletes depending on their physiology and motor skills (15). In a game like basketball, in which players move all around the court, HR is affected by both the physical demands on the court and the emotional intensity. In some cases, athletes' HRs can be abnormally elevated even before competitions. From this point of view, HRV monitoring is emerging as a supportive method to improve sport-specific performance in basketball players potentially through improved breathing and vagal modulation of parasympathetic activity (16). It has been reported that HRV biofeedback training reflects autonomic nervous system homeostasis and a positive psychophysiologic change and is a self-regulatory intervention aimed at reducing psychophysiologic stressors resulting in improvement in sport-specific skills and optimal performance (16, 17).

In a game such as basketball, in which the physiological and psychological stress level can change rapidly and frequently during the game, HRV in the players may affect their physical fitness and thus their sporting performance. In addition, players' physical fitness and therefore their game performance may be affected by the balance in the autonomic nervous system. Based on these contexts, the aim of this study was to examine the relationship between HRV parameters and sportive performances of basketball players.

METHODS

Participants

Thirty-two male licensed basketball players who met the inclusion criteria for the study were interviewed and the study was completed with 20 eligible participants (Figure 1). Before starting the study, the volunteers were verbally informed about the content, purpose, duration, and evaluations to be performed, and the participants also read and signed the Informed Consent Form.

The inclusion criteria were as follows: male gender, being between 18 and 25 years of age, having an active basketball license and having been in active

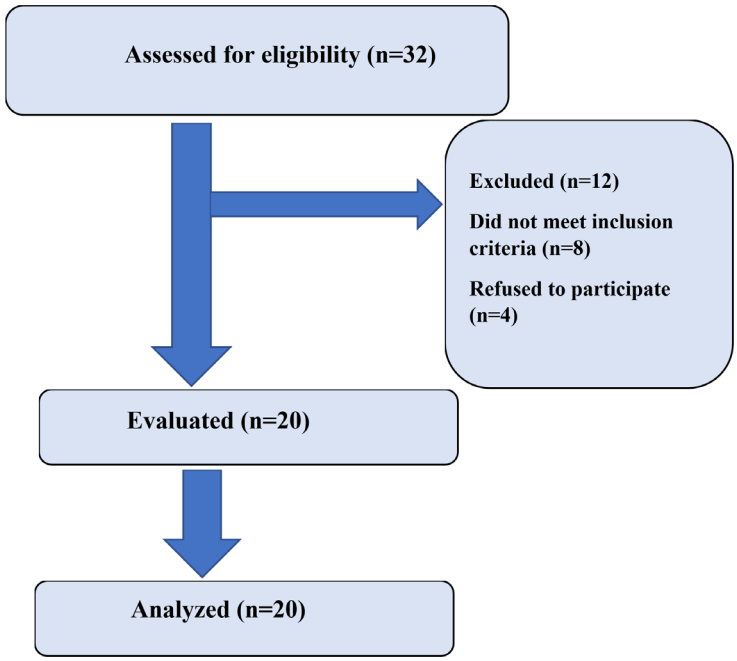

Figure 1. Flowchart of the study.

competition for at least 4 years, not having any pain or discomfort at the time of the assessment, not having participated in intense activity that would affect the assessments at least 24 hours before the test, being full, not having consumed alcohol, cigarettes, and caffeine at least 24 hours before the test, and having slept at least 8 hours on the night of the day of the assessment. Exclusion criteria were: having an injury within the last 6 months that required a break from sports and having any systemic disease.

Procedure

The ethics committee approval of this cross-sectional study was obtained from X University Ethics Committee (#46, Date:14/01/2021). The evaluations in our study were conducted in Y Basketball Club Sports Hall between January 2021 and September 2022. In addition to demographic information, the participants' explosive power (Vertical Jump Test), upper extremity power (Seated Medicine Ball Throw Test), agility performance (T Agility Test), lower extremity balance (Lower Extremity Y Balance Test), upper extremity balance (Upper Extremity Y Balance Test), basketball performance (Johnson Basketball Performance Tests), and HRV (Polar H10 Chest Strap) were evaluated.

Vertical Jump Test:

It is a method applied to measure the explosive power of individuals in the vertical direction (3). For this test, the athletes stood next to the wall with their feet shoulder-width apart. In this position, the highest point they could reach with their hand was marked with the help of a tape. Then the athlete was asked to jump in a vertical direction and again the highest distance reached was marked. After a total of three attempts, the distance between the marked points was measured. The best distance recorded was recorded in centimeters (cm) and then these measurement results were converted into watts using the following power formula (18)

Power (watts) = 21.67 x Body weight (kg) x Vertical displacement (m) x 0.5 (3).

Seated Ball Throw Test

During this test, the athletes were asked to sit on the floor with their waist, back, shoulders, and head supported against the wall to evaluate upper extremity strength and power. Care was taken to ensure that their knees were in full extension. Then, they were asked to throw a medicine ball weighing two kilograms (kg) to the farthest distance using both hands without disturbing the back, shoulder,

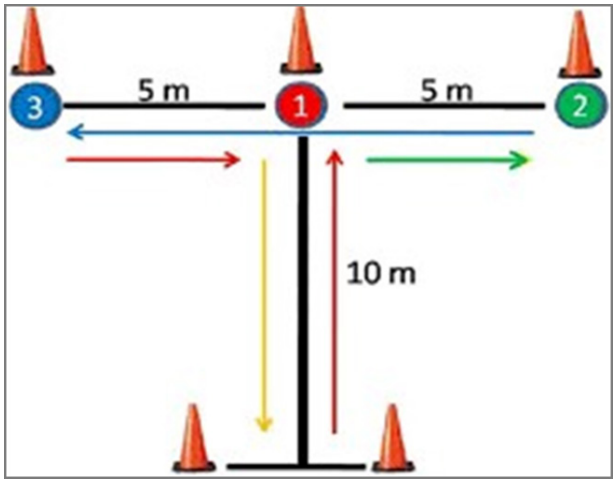

Figure 2. T Agility Test

and head support. The distance the ball fell was marked and recorded in cm. Arm lengths measured before the test were subtracted from the distances obtained to normalize the results. A total of four trial throws were made and the mean value of these throws was taken as the basis. The distance between the wall and the most proximal end of the chalk mark was subtracted from the total shot distance. The mean distance was calculated for further analysis (3, 18, 19).

T Agility Test

The aim of this test is to assess all-round speed, agility, and body control. The athlete was asked to first run forward starting from the center cone and touch the cone in front. Then they were asked to run sideways to the right and left cones and touch each in the same way. After touching the leftmost cone, they were asked to touch the cone in the middle and finally to run backwards towards the starting point. The stopwatch was stopped when they reached the starting point. A total of three trials were performed and the best time was recorded in seconds (3, 18, 20) (Figure 2).

Lower Extremity Y Balance Test

With the Lower Extremity Y Balance Test, dynamic balance and postural control on one leg were evaluated. Before starting the test, the floor was marked in three directions (anterior-posteromedial-posterolateral) according to the protocol. The angles between these marks were 135° -135°-90°. After warming up, the athlete placed one foot in the center of these marks for the starting position. The athlete was asked to reach the maximum distance in the preset direction and return to their original position. Three attempts were made for each direction and the same procedure was repeated for

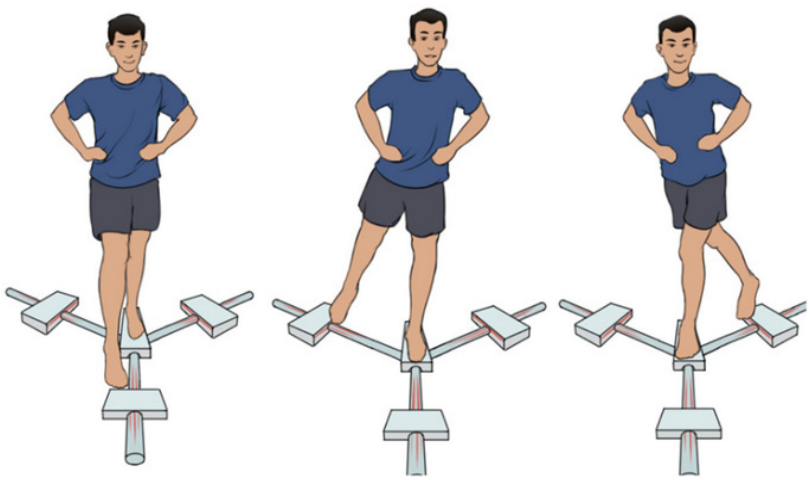

Figure 3. Lower Extremity Y Balance Test (22).

the contralateral side and the best results were recorded. While performing the test, the person should not lose balance and should not lift the heel off of the center. For normalization, the maximum reachable distance was divided by the leg length distance between the spina iliaca anterior superior and medial malleolus measured with a tape measure while lying supine and multiplied by 100 (21) (Figure 3).

Upper Extremity Y Balance Test

The Upper Extremity Y Balance Test is a widely used clinical and field test to investigate the mobility and stability of the upper quadrant (23). For the test, the floor was marked in three directions (inferolateral-superolateral-medial) at 135°-135°-90° angles with the help of tape. The athlete took a push-up position with their feet shoulder-width apart. The hand to be tested was placed at the junction of the three lines. The other free hand was then moved as far as it could reach in the specified direction and returned to its original position. This process was repeated three times in all directions for both extremities and the best result for each direction was recorded. To ensure normalization between athletes, the distance from the C7 spinous process to the most distal third finger was measured with a tape measure with their shoulders in 90° abduction and elbows in full extension position, and the best distance recorded at the end of the test was divided by arm length and multiplied by 100 (24).

Johnson Basketball Performance Test Battery

The Johnson Basketball Test Battery was developed by L. William Johnson to assess potential basketball talent and basic basketball skills. The evaluation of basic basketball skills is categorized under three headings, namely, fast throw test, accurate throw test, and dribbling tests (25).

Johnson Field Goal Speed Test

The aim of this test is to evaluate the successful throwing performance of a person under stress. During the test, the athlete was asked to take a position under the basket and shoot for 30 seconds without stopping. The athlete was given 1 point for each successful shot. At the end of the time, the total number of successful shots was recorded. Three attempts were made and the average of these attempts was taken and analyzed (26).

Johnson Throw for Accuracy

Three rectangles were drawn on the wall, which were nested according to the protocol. Then, a point with a distance of 12.2 meters (40 feet) from the wall was marked and the athlete stood on this point to start. They were asked to throw ball 10 times from this point and hit the innermost rectangle. The innermost rectangular area was worth 3 points, the outer rectangular area was worth 2 points, and the outermost rectangular area was worth 1 point. Zero point was given for the shot that did not hit the rectangular area. A total of three trials were performed and the average of these trials was taken and recorded (25, 26).

Johnson Dribble Test

The aim of this test is to assess a person's dribbling ability and agility. According to the protocol, a total of five cones were required. The distance between the start and the next cone was set to 3.65 m (12 feet), while the distance between the other cones was set to 1.82 m (6 feet). The athlete started dribbling from the starting point and when they reached the last cone, they turned around the cone and continued dribbling towards the starting point. They were asked to perform this cycle continuously for 30 seconds. The athlete received 1 point for each cone they passed and their score for the duration was calculated. A total of three trials were performed and the average of these trials was taken for analysis (25, 26).

HRV Assessment

In our study, a Polar H10 (Polar Electro, Kempele, Finland) chest strap, which was validated, was used as a HR monitor (27). Elite HRV, which is a mobile phone application with established validity and reliability, was used to analyze the data obtained (28). The protocol for the evaluation of HRV was determined in accordance with the guidelines of the European Society of Cardiology and the North American Electrophysiology Society for standardizing physiological and clinical studies (29). The evaluations were performed for each athlete in a quiet, semi-dark room with a temperature of 22-25°C (30). It was ensured that the athlete had not

participated in a strenuous activity 24 hours before the assessment and had slept at least 8 hours on the day of the assessment (30). The portable HR monitor was placed on the xiphoid process of the athlete via a chest strap in a non-disturbing manner and the measurements were continued by connecting with the phone application. Then, the athlete rested for 15 minutes and the protocol was started. The test was performed in the supine position for 8 minutes and then in standing position for 7 minutes. The 3rd to 8th minute lying position and the 9th to 14th minute standing position results were recorded (29). The measurements were repeated in 5-min recordings in these positions, before and after the assessments and during the Johnson Basketball Performance Tests, taking into account the hypothesised changes in HRV during rest, assessment and recovery (25, 26). Root Mean Square of Successive Differences (RMSSD), Standard Deviation of NN Intervals (SDNN), Total Power (TP), Low-Frequency/High-Frequency (LF/HF) ratio, LF and HF parameters were recorded.

Statistical Methods and Analysis

IBM SPSS Statistics 21 (IBM, Chicago, IL) computer program was used for statistical analysis and calculations. In the sample size calculation made using the G-Power 3.1 program before starting the study, the correlation coefficient r=0.7942 (strong correlation) in the study examining the relationship between vertical jump and LF/HF, which is a parameter reflecting sympathetic and parasympathetic modulation in basketball players, was taken as r=0.7942 (strong correlation) and it was predicted that 12 people are needed in the study for 90% power and 95% confidence interval (31). However, due to the availability of more athletes, the study was conducted with 20 participants.

The demographic data of the athletes are expressed as mean±standard deviation. Shapiro-Wilks test was used to test the conformity of the data to normal distribution. The correlations between HRV and sportive performances were analyzed using Pearson's correlation analysis test. According to the correlation coefficient (r), the degree of association was interpreted as weak (0.00-0.29), low (0.30-0.49), moderate (0.50-0.69), strong (0.70-0.89) and very strong (0.90-1.00). The significance level was accepted as $p<0.05$ for all analyses.

RESULTS

The study was completed with 20 male basketball players with a mean age of 19.40±1.04 years. The mean number of years of being a licensed athlete was 7.95±2.43 and the mean number of exercise days per week was 6.00±.00. Data on other demo-

Table 1. Demographic characteristics of the athletes.

	n	Mean±SD
Age (year)	20	19.40±1.04
Height (cm)	20	194.65±8.26
Weight (kg)	20	90.00±10.86
BMI (kg/m^2)	20	23.68±1.51
License Year (year)	20	7.95±2.43
Exercise Frequency (days/week)	20	6.00±.00

cm: Centimeter, kg: Kilogram, n: Number of participants, SD: Standard Deviation.

Table 2. Descriptive data of sportive performance parameters.

	n	Mean±SD
Vertical jump test (watt)	20	585.59±54.89
Seated chest ball throw test (watt)	20	7422.01±1484.31
T agility test (s)	20	10.02±.59
Lower Extremity Y Balance Test (%)	20	99.04±9.08
Upper Extremity Y Balance Test (%)	20	92.67±11.96
Fast throwing performance (point)	20	19.77±1.92
Accurate throwing performance (point)	20	20.97±2.50
Dribbling performance (point)	20	34.56±3.78

n: Number of participants, SD: Standard Deviation, s: second, %: Percent

Table 3. Relationships between vertical jump test, Seated chest ball throw test, T Agility Test and HRV parameters

	Measuring Positions		Time Dependent Parameters		Frequency Dependent Parameters			
			RMSSD (ms)	SDNN (ms)	TP (ms²)	LF/HF	LF (ms²)	HF(ms²)
Vertical Jump (watt)	LDBE	r	-.066	.119	-.039	.323	.101	-.081
		p	.782	.618	.870	.164	.673	.734
	SBE	r	-.087	-.185	-.226	-.251	-.080	-.011
		p	.715	.435	.339	.286	.738	.965
	FT	r	-.188	-.380	-.165	-.111	-.195	-.126
		p	.427	.098	.486	.640	.409	.596
	AT	r	.311	-.350	.150	-.490	-.065	.322
		p	.182	.130	.527	.028*	.787	.166
	D	r	-.104	-.687	-.514	-.444	-.626	-.198
		p	.663	.001*	.020*	.050	.003*	.402
	LDAE	r	-.454	-.304	-.579	.277	-.576	-.481
		p	.044*	.193	.007*	.238	.008*	.032*
	SAE	r	-.432	-.502	-.457	.156	-.463	-.471
		p	.057	.024*	.043*	.510	.040*	.036*
Seated Chest Ball Throw Test (watt)	LDBE	r	-.859	-.704	-.717	.598	-.635	-.860
		p	.001*	.001*	.003*	.005*	.003*	.001*
	SBE	r	-.644	-.435	-.445	.426	-.385	-.680
		p	.002*	.056	.049*	.061	.094	.001*
	FT	r	-.395	-.244	-.380	.256	-.278	-.490
		p	.084	.301	.098	.277	.235	.028*
	AT	r	-.220	-.272	-.125	.051	-.140	-.171
		p	.352	.246	.600	.830	.556	.470
	D	r	-.244	.331	-.057	-.155	-.149	-.026
		p	.300	.154	.811	.514	.531	.915
	LDAE	r	-.278	-.218	.030	.471	.137	-.233
		p	.235	356	.900	.036*	.565	.323
	SAE	r	-.362	-.367	-.343	-.005	-.343	-.209
		p	.116	.112	.139	.985	.139	.376
T Agility Test (sec)	LDBE	r	.017	.060	-.057	-.009	-.012	.017
		p	.942	.801	.811	.970	.960	.942
	SBE	r	-.065	-.058	.223	.120	.254	-.052
		p	.784	.808	.345	.615	.279	.828
	FT	r	-.087	-.081	-.144	-.428	-.067	-.099
		p	.714	.736	.545	.060	.779	.677
	AT	r	-.129	-.035	-.073	-.023	-.070	-.173
		p	.589	.885	.760	.922	.769	.465
	D	r	-.091	.146	-.053	-.064	-.047	.084
		p	.701	.539	.825	.789	.843	.726
	LDAE	r	.227	.076	.409	-.156	.373	.314
		p	.335	.750	.074	.512	.105	.178
	SAE	r	.078	.009	-.024	-.644	-.072	.370
		p	.743	.970	.920	.002*	.762	.108

AT: Accurate throwing, D:Dribbling, FT: Fast throwing, HF: High frequency, LDAE: Lying down after evaluation, LDBE: Lying down before evaluation, LF/HF: Low frequency/high frequency, LF: Low frequency, ms: Milliseconds, SAE: Standing after evaluation, SBE: Standing before evaluation, TP: Total power (HRV measurements were taken after the athletes rested for 15 minutes after the test). According to the correlation coefficient (r), the degree of association was interpreted as weak (0.00-0.29), low (0.30-0.49), moderate (0.50-0.69), strong (0.70-0.89) and very strong (0.90-1.00). The significance level was accepted as p*<0.05 for all analyses.

graphic and descriptive characteristics of the players are shown in Table 1.

The descriptive data of Vertical Jumping, Seated Chest Ball Throw, T Agility, Lower Extremity Y Balance, Upper Extremity Y Balance, Fast Throw, Accurate Throw, and Dribble Tests results are shown in Table 2.

The relationships between the tests evaluating the

Table 4. Relationships between Lower Extremity Y Balance Test, Upper Extremity Y Balance Test, Fast Throw Performance and HRV parameters

	Measuring Positions		Time Dependent Parameters		Frequency Dependent Parameters			
			RMSSD (ms)	SDNN (ms)	TP (ms²)	LF/HF	LF (ms²)	HF (ms²)
Lower Extremity Y Balance (%)	LDBE	r	.063	.089	-.035	.202	.150	-.018
		p	.791	.710	.885	.394	.527	.940
	SBE	r	.239	.195	.113	-.259	.072	.104
		p	.310	.409	.636	.271	.762	.663
	FT	r	-162	-.080	-.027	-.086	-.008	-.131
		p	.494	.738	.910	.719	.975	.582
	AT	r	.167	.111	.277	-.066	.328	.305
		p	.482	.640	.238	.782	.158	.191
	D	r	-.285	-.272	-.370	.183	-.347	-.331
		p	.223	.246	.108	.439	.133	.154
	LDAE	r	-.340	-.083	-.224	.248	-.200	-.292
		p	.143	.729	.342	.292	.398	.212
	SAE	r	.056	.033	.126	-.014	.120	-.005
		p	.816	.890	.596	.955	.613	.985
Upper Extremity Y Balance (%)	LDBE	r	.209	.095	.238	-.077	.188	.143
		p	.376	.691	.313	.748	.427	.548
	SBE	r	.385	.311	.111	-.209	-.051	.314
		p	.094	.182	.640	.376	.830	.177
	FT	r	.244	.159	.278	.212	.186	.206
		p	.301	.502	.235	.369	.431	.384
	AT	r	.174	.002	-.006	.074	.041	.132
		p	.462	.995	.980	.758	.865	.578
	D	r	.063	-.147	.003	.197	.000	-.158
		p	.791	.535	.990	.405	1.000	.506
	LDAE	r	-.189	-.050	-.320	.095	-.310	-.208
		p	.424	.835	.169	.691	.184	.380
	SAE	r	.192	.230	.236	.328	.272	-075
		p	.416	.329	.316	.158	.246	.753
Fast Throw Performance (point)	LDBE	r	-.397	-.372	-.313	.004	-.339	-.336
		p	.083	.106	.179	.987	.144	.148
	SBE	r	-.183	.002	.024	.427	.060	-.206
		p	.440	.995	.920	.061	.801	.383
	FT	r	-.242	.070	-.205	.346	-.121	-.313
		p	.303	.769	.387	.136	.611	.179
	AT	r	-.601	.177	-.041	.668	.161	-.357
		p	.005*	.456	.865	.001*	.497	.123
	D	r	-.059	.493	.289	.327	.294	.004
		p	.806	.027*	.216	.160	.208	.987
	LDAE	r	.007	-.096	.209	.105	.224	.008
		p	.977	.688	.378	.661	.343	.975
	SAE	r	.042	.005	.125	.005	.105	.257
		p	.860	.982	.600	.985	.661	.275

AT: Accurate throwing, D:Dribbling, FT: Fast throwing, HF: High frequency, LDAE:Lying down after evaluation, LDBE: Lying down before evaluation, LF/HF: Low frequency/high frequency, LF: Low frequency, ms: Milliseconds, SAE: Standing after evaluation, SBE: Standing before evaluation, TP: Total power (HRV measurements were taken after the athletes rested for 15 minutes after the test). According to the correlation coefficient (r), the degree of association was interpreted as weak (0.00-0.29), low (0.30-0.49), moderate (0.50-0.69), strong (0.70-0.89) and very strong (0.90-1.00). The significance level was accepted as p*<0.05 for all analyses.

sportive performance of the basketball players participating in the study and the parameters of HRV are presented in separate tables for each test.

Relationships between vertical jump test, Seated chest ball throw test, T Agility Test and HRV parameters

• Statistically significant relationships were found between vertical jump test and RMSSD, SDNN, TP, LF/HF ratio, LF and HF parameters in various directions and at different levels before and after the evaluation (p<0.05) (Table 3).

• Statistically significant relationships were found between the Seated Chest Ball Throw Test and RMSSD, SDNN, TP, LF/HF ratio, LF and HF param-

Table 5. Relationship between accurate throwing performance, dribbling performance and HRV parameters.

	Measuring Positions		Time Dependent Parameters		Frequency Dependent Parameters			
			RMSSD (ms)	SDNN (ms)	TP (ms²)	LF/HF	LF (ms²)	HF (ms²)
Accurate throwing (point)	LDBE	r	-.343	-.389	-.365	.476	-.092	-.384
		p	.139	.090	.114	.034*	.700	.094
	SBE	r	-.295	-.178	-.334	.235	-.266	-.398
		p	.206	.453	.150	.318	.257	.082
	FT	r	-.331	-.145	-.096	.341	-.186	-.155
		p	.154	.541	.686	.141	.432	.513
	AT	r	-.081	.012	.203	.065	.225	.094
		p	.733	.960	.391	.786	.341	.693
	D	r	-.164	.049	-.177	-.023	-.219	-.145
		p	.489	.838	.455	.925	.353	.543
	LDAE	r	-.180	.100	-.173	.475	-.047	-.282
		p	.447	.674	.465	.034*	.845	.229
	SAE	r	-.057	-.148	.081	.286	.087	-.127
		p	.810	.532	.735	.221	.716	.595
Dribbling performance (point)	LDBE	r	.075	.029	-.080	.083	.033	-.025
		p	.752	.902	.738	.728	.890	.917
	SBE	r	.234	.167	.019	-.325	.124	.258
		p	.320	.481	.937	.162	.601	.271
	FT	r	.028	.107	.208	.255	.187	.121
		p	.907	.653	.379	.277	.430	.613
	AT	r	-.019	-.048	.004	.023	-.003	.091
		p	.937	.840	.987	.922	.990	.702
	D	r	-.125	-.313	-.287	-.106	-.374	-.264
		p	.599	.179	.220	.658	.104	.261
	LDAE	r	-.462	-.127	-.525	.570	-.408	-.584
		p	.040*	.593	.017*	.009*	.074	.007*
	SAE	r	-.011	-.017	.067	.399	.084	-.152
		p	.965	.945	.779	.082	724	.522

AT: Accurate throwing, D:Dribbling, FT: Fast throwing, HF: High frequency, LDAE:Lying down after evaluation, LDBE: Lying down before evaluation, LF/HF: Low frequency/high frequency, LF: Low frequency, ms: Milliseconds, SAE: Standing after evaluation, SBE: Standing before evaluation, TP: Total power (HRV measurements were taken after the athletes rested for 15 minutes after the test). According to the correlation coefficient (r), the degree of association was interpreted as weak (0.00-0.29), low (0.30-0.49), moderate (0.50-0.69), strong (0.70-0.89) and very strong (0.90-1.00). The significance level was accepted as p*<0.05 for all analyses.

eters in different directions and levels before and after the evaluation (p<0.05) (Table 3).

• The relationships between T agility test and HRV parameters are shown in Table 3. According to these results, a moderate negative correlation was found for the frequency-dependent LF/HF parameter in the standing position after the evaluation and this relationship was statistically significant (p<0.05) (Table 3).

Relationships between Lower Extremity Y Balance Test, Upper Extremity Y Balance Test, Fast Throw Performance and HRV parameters

• The correlations between the Lower Extremity Y Balance Test and HRV parameters of the athletes are shown in Table 4. According to these results, no statistically significant correlation was found between these variables (p>0.05) (Table 4).

• The relationships between the Upper Extremity Y Balance Test and HRV parameters are shown in Table 4. According to these results, no statistically significant correlation was found between these variables (p>0.05) (Table 4).

• Statistically significant relationships were found between fast throw performance test and RMSSD, SDNN and LF/HF ratio parameters in different directions and levels (p<0.05). (Table 4).

Relationship between accurate throwing performance, dribbling performance and HRV parameters

• For the LF/HF parameter, statistically significant correlations were found in the pre-assessment lying position and in the lying down after evaluation ($p<0.05$) (Table 5).

• Statistically significant relationships were found between dribbling performance test and RMSSD, TP, LF/HF ratio and HF parameters in different directions and levels. ($p<0.05$) (Table 5).

DISCUSSION

This study aimed to examine the relationship between HRV parameters and sportive performances of basketball players, and we found various levels of relationships between some performance parameters and HRV parameters.

When studies in the literature in this field are examined, it is seen that the contexts for the relationship between physical performance, training status, muscle strength and cardiorespiratory fitness in athletes have been expanded (32, 33). Carrasco-Poyatos et al. followed the athletes' performance during the training period guided by HRV. The conclusion emphasized in this study was that training guidance designed to balance the autonomic nervous system may have a positive effect on athletes' athletic performance (32). In a study of 24 professional basketball players of the Spanish Basketball League, a significant correlation was found between HRV and respiratory threshold or anaerobic threshold. According to this study, when determining the respiratory threshold in basketball players, training loads can be evaluated in a practical and low-cost way with HRV. Therefore, it is emphasized that HRV will be an alternative method to assess respiratory threshold without laboratory technologies, which are difficult to use and quite expensive (33).

It has been suggested that during competition in the game of basketball, there is a decline in vertical jump performance as the athlete becomes fatigued, but this is not only a muscular response but also a response of the autonomic nervous system. At rest and during the inactive phases of the vertical jump, the main activity of the heart is controlled by the parasympathetic division of the autonomic nervous system. In addition, the activation of sympathetic activities increases during performance (31). In our study, there was a relationship between vertical jump and RMSSD, one of the time-dependent parameters, in all measurement positions, but the significance was only negative and low in the lying position after the evaluation. RMSSD is the main parameter used to monitor vagal-based changes observed in HRV, i.e., it appears as a reflection of the parasympathetic system (10). This may be explained by the fact that the RMSSD parameter mainly reflects vagal activity. Therefore, it can be accepted as a possible result that these parameters are related in the post-test recovery process. The result of this parameter in our study indicates, albeit weakly, that an increase in vertical jump performance is associated with a decrease in RMSSD. In other words, if the parasympathetic system effect decreases (which means that sympathetic system activity increases), vertical jump performance will be better. Negative moderate correlations were found between vertical jump performance and SDNN parameter during dribbling performance and negative moderate correlations were found in standing position after evaluation. SDNN is a general marker of autonomic nervous system activity, and its increase reflects general well-being (10). The fact that its increase reflects well-being may be interpreted as an increase in parasympathetic activation and the negative correlation may be an indication that sympathetic system activation is needed for vertical jump performance. We also found various correlations between the vertical jump performance of athletes and some of the frequency-dependent parameters, among which LF is known to reflect baroreflex activity, not cardiac sympathetic innervation in resting conditions (10). When respiration slows down, vagal activity can cause marked oscillations in heart rhythms that cross the LF band (34). Therefore, since the respiratory values of our athletes did not decrease dramatically in our study, we think that it would not be correct to comment only on LF. HF is considered to be an indicator of the parasympathetic nervous system because it is associated with HR affected by the respiratory cycle (34). It has been reported that the HF parameter correlates with parasympathetic activity and represents respiratory vagal

activity (35, 36). The results of our study are consistent with the literature and show that vertical jump performance will increase in the decrease of HF parameter, that is, in the increase of sympathetic nervous system activity.

We found different levels of correlations with various parameters of HRV with the Seated Chest Ball Throw Test, which is used to evaluate the throwing skill, which is related to the concept of strength in the basketball game. Since lower RMSSD and SDNN values are generally indicators of good health (10), lower values of these parameters would improve the performance of the seated chest ball throw. The results of our study also indicate this. The LF/HF ratio is an indicator of sympatho-vagal balance and when a decrease in this ratio is accepted as a shift towards parasympathetic balance (8), as our results show, the positive relationship with the power parameter tested with the seated chest ball throw indicates that there should be sympathetic activity dominance for power increase.

It is advantageous to have good agility in movements such as fast offense, blocking, and throwing in basketball competition (20). In our results, a moderate negative correlation was found for the frequency-dependent LF/HF parameter in the standing position after the evaluation. According to this result, we can say that there is a relationship between the decrease in the time required for the agility test and the dominance of sympathetic activation. In a study investigating endurance training and HRV parameters in basketball players, it was shown that intermittent endurance training stimulated the vagus and decreased heart rate. This is related to increased parasympathetic activity (37).

We found statistically significant relationships between dribbling performance, one of the sub-domains of the Johnson Basketball Test Battery, and the parameters RMSSD, TP, LF/HF ratio and HF. Among these, the moderate negative relationship we found between the RMSSD parameter and LBDA during accurate shooting performance suggests that sympathetic system activation is necessary for fast shooting performance, since RMSSD is considered a reflection of the parasympathetic system, but our results do not support this idea (5). The low positive correlation we found for the SDNN parameter during dribbling performance suggests that SDNN should also increase for fast-throw performance, as SDNN is a general marker of autonomic nervous system activity and its increase reflects general well-being. However, the results obtained are not sufficiently powered to make such a generalization (5). The moderately significant positive correlations we found for the LF/HF parameter during accurate passing performance reflect that sympatho-vagal balance should also increase to increase fast throwing performance.

In summary, since these results may indicate that HRV may be related to various parameters of sportive performance and the addition of HRV to athlete assessments may be beneficial in terms of objective results, we suggest that HRV assessments should be measured at different periods throughout the season. In addition, the addition of HRV to the assessment phases of athletes may provide important information about autonomic control of training and recovery processes. However, it is thought that more detailed studies are needed in this field for clear information.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Declaration of Generative AI and AIassisted technologies in the writing process: Generative AI and AIassisted technologies were not used in the writing of this article.

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Şeyda ERCAN YÜCEER[1], PT, MSc
Hatice YAKUT[2], PT, PhD, Assoc. Prof.

1 Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Mugla Sitki Kocman University, Mugla, Türkiye
2 Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Suleyman Demirel University, Isparta, Türkiye

Correspondence (İletişim):

Şeyda ERCAN YÜCEER
Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Mugla Sitki Kocman University, Mugla, Türkiye,
seydaercan22@gmail.com
ORCID: 0000-0002-9921-6367

Hatice YAKUT
E-mail: haticeyakut@sdu.edu.tr
ORCID: 0000-0002-0033-0144

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THE ROLE OF PREOPERATIVE FACTORS ON ACUTE POSTOPERATIVE PAIN AND PHYSICAL FUNCTION AFTER TOTAL KNEE ARTHROPLASTY

ORIGINAL ARTICLE

ABSTRACT

Purpose: Many preoperative factors can affect the pain and physical function complaints reported in the acute period after total knee arthroplasty (TKA). This study was planned to reveal the preoperative factors that may affect pain and physical function in the acute period of patients post-TKA.

Methods: Seventy patients (53 women, 17 men) with a mean age of 66.5±7.53 years were enrolled in this study. Before the surgery, the Hospital for Special Surgery Knee Scoring, a Visual Analog Scale, the Tampa Kinesiophobia Scale, the Hospital Anxiety and Depression Scale, the International Physical Activity Questionnaire Short Form and the Body Awareness Questionnaire were used to evaluate the patients. The Brief Pain Inventory and the Timed Up and Go Test were used for post-surgery assessments.

Results: Postoperative acute pain (PAP) was associated with preoperative kinesiophobia, anxiety, depression, and pain severity (r=0.684, p=0.000; r=0.424, p=0.000; r=0.329, p=0.005; r=0.259, p=0.030, respectively). Postoperative acute physical performance (PAPP) was associated with preoperative kinesiophobia (r=0.280 ; p=0.019). It was found that there was no relationship between preoperative body awareness and acute postoperative pain and physical performance (p>0.05). There was a significant difference in PAPP between inactive and inactive preoperative physical activity levels (p=0.000). There was a statistically significant difference between the PAP and PAPP between patients with preoperative knee pain duration of 5 years and under and patients with 6 years or more (p=0.025).

Conclusion: Through the assessment of the preoperative risk factors identified in this study, patients at higher risk of acute postoperative pain and poor physical performance can be identified.

Keywords: Acute Pain, Knee Arthroplasty, Physical Function, Preoperative Predictor, Recovery

TOTAL DİZ ARTROPLASTİSİ SONRASI AKUT POSTOPERATİF AĞRI VE FİZİKSEL FONKSİYON ÜZERİNDE PREOPERATİF FAKTÖRLERİN ROLÜ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Total Diz Artroplastisi (TDA) sonrası akut dönemde bildirilen ağrı yakınmalarını ve fiziksel fonksiyonu etkileyebilecek preoperatif faktörler mevcuttur. Bu çalışma, TDA sonrası hastaların akut dönemde ağrı ve fiziksel fonksiyonuna etki edebilecek preoperatif faktörleri ortaya çıkarmak amacıyla planlandı.

Yöntem: Çalışmaya yaş ortalamaları 66,5 ± 7,53 olan 70 hasta (53 kadın, 17 erkek) dahil edildi. Ameliyat öncesi hastaları değerlendirmek için Hospital for Special Surgery Diz Skorlaması, Vizüel Analog Skalası, Tampa Kinezyofobi Ölçeği, Hastane Anksiyete ve Depresyon Ölçeği, Uluslararası Fiziksel Aktivite Anketi Kısa Formu ve Vücut Farkındalığı Anketi kullanıldı. Ameliyat sonrası değerlendirmeler için Kısa Ağrı Anketi ve Süreli Kalk ve Yürü Testi kullanıldı.

Sonuçlar: Postoperatif akut ağrı (PAA), preoperatif kinezyofobi, anksiyete, depresyon ve ağrı şiddeti ile ilişkili bulunurken (r=0,684, p=0,000; r=0,424, p=0,000; r=0,329, p=0,005; r=0,259, p=0,030, sırasıyla) postoperatif akut fiziksel performans (PAFP) preoperatif kinezyofobi ile ilişkili bulunmuştur (r=0,280, p=0,019). Preoperatif vücut farkındalığı ile PAA ve PAFP ile ilişkili olmadığı bulunmuştur (p>0,05). Preoperatif fiziksel aktivite düzeyi inaktif olanlar ile inaktif olmayanlar arasında PAFP açısından anlamlı fark bulunmuştur (p=0,000). Ameliyat öncesi diz ağrısı süresi 5 yıl ve altında olan hastalar ile 6 yıl ve üzerinde olan hastalar arasında PAA ve PAFP arasında istatistiksel olarak anlamlı bir fark bulunmuştur (p=0,025).

Tartışma: Bu çalışmada tanımlanan preoperatif risk faktörlerinin değerlendirilmesi yoluyla akut postoperatif ağrı ve kötü fiziksel performans riski daha yüksek olan hastalar belirlenebilir.

Anahtar kelimeler: Akut Ağrı, Diz Artroplastisi, Fiziksel Fonksiyon, Preoperatif Tahmin Edici, İyileşme

INTRODUCTION

Total Knee Arthroplasty (TKA) is a reliable treatment method that is considered as the gold standard in the treatment of late-stage osteoarthritis and provides function in a short time in patients who do not respond to conservative treatments (1). The primary objectives of TKA are to reduce pain, increase functionality, correct deformities in the knee and consequently, improve the patient's quality of life (2). However post-TKA some patients report significant reductions in knee pain and increased functionality, while others report ongoing or even worsening pain. In the first days after TKA, a delay in mobilization time may occur as a result of the lack of pain-reducing interventions. Delayed mobilization may lead to an increased risk of developing venous thrombosis, poor wound healing, prolonged hospital stay and psychological problems, and reduced patient satisfaction. In addition, long-term acute postoperative pain is an important risk factor in the development of chronic pain (3). Studies have reported that 15%-25% of patients with TKA need to identify related factors that may cause patient dissatisfaction (4). These findings emphasis the importance of identifying modifiable determinants with the potential to alleviate poorly managed acute postoperative pain and loss of function. When considering modifiable preoperative factors that may affect pain and physical performance after TKA, most of the studies in the literature are studies of patients in the subacute and chronic phases. In studies, postoperative subacute and chronic pain was associated with modifiable factors such as preoperative pain catastrophizing, anxiety, chronic pain intensity and knee pain (5-9). Studies have shown that acute postoperative pain and physical performance are associated with preoperative modifiable factors such as anxiety, depression, pain catastrophizing and high pain level. However, due to the heterogeneity of study methodologies and results, there is uncertainty regarding the relationships between the findings (10-13). No study has been found on preoperative fear of movement, body awareness, duration of chronic knee pain and physical activity levels that may affect postoperative pain and physical performance in the acute period.

People who are physically active and exercise before surgery have a shorter hospital stay after the operation. However, these recovery outcomes are debated in patients undergoing knee arthroplasty (14). Although the relationship between preoperative pain and postoperative acute pain is known in studies, it has not been investigated whether preoperative knee pain duration is related to postoperative acute pain and physical performance.

This study aimed to examine the relationship of pain and physical performance in patients who underwent TKA with preoperative movement fear, anxiety, depression, body awareness, and pain level at the time of interview. The study also aimed to investigate whether there is a difference between acute postoperative pain and physical performance of patients with different levels of preoperative physical activity and chronic knee pain duration.

METHODS

This is a cross-sectional study. The study was conducted between March and August 2019 at Süleyman Demirel University Faculty of Medicine, Department of Orthopedics and Traumatology, with 70 patients (53 women, 17 men) aged between 40-85 years who were planned to undergo TKA. The research was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from the patients through a preliminary form informing them about the study. Patients who had the ability to walk at least 10 meters before surgery, who could understand written and oral commands, and who will undergo unilateral TKA were included in the study. Patients who had previously undergone knee replacement surgery, were diagnosed with a psychiatric problem, with a known cancer history, having hip and ankle problems that would interfere with walking and evaluation, patients with cardiovascular and lung disease (chronic obstructive pulmonary disease, pacemaker use, heart failure), and morbidly obese patients were excluded from the study (10, 15, 16).

All patients were evaluated the day before the operation and on the 3rd day after the operation. First, patients were verbally informed about the purpose of the study and the evaluations to be conducted. Following this, they signed the 'Informed Consent

Form' in writing. Subsequently, the "Informed Voluntary Patient Form" was signed in writing. After collecting the preoperative demographic information and medical histories, pain intensity, fear of movement, anxiety and depression levels, physical activity status, and body awareness were evaluated. Three days after the surgery, pain intensity and physical performance were re-evaluated.

All patients were operated on by experienced surgeons with at least 5 years of TKA experience. A three-compartment cemented TKA protocol was applied using a medial parapatellar approach, without patella replacement. Primary TKA was performed on all patients and no patients were given simultaneous bilateral knee arthroplasty. During the 4-6-day hospital stay, the patients were managed with a standardized medical, pharmaceutical, and rehabilitation treatment protocol. Starting on postoperative day 1, patients were assisted with ambulation using a walker, supported by a physiotherapist, within their weight-bearing capacity. The goal of discharge related to functionality in the patient was an independent and safe ambulation on a flat and non-slippery floor with auxiliary walking devices (walker, tripod, cane, etc.). Before being discharged, the patients were given home exercise programs that they could do on the pain limit.

Preoperative Evaluation Methods

Knee Function

The HSS Knee Scoring is an area-specific questionnaire developed as a standard tool designed to evaluate outcomes in all knee disorders and especially in patients who underwent TKA. It includes 6 different categories: Pain, Function, Joint Mobility (ROM), Muscle Strength, Flexion Deformity, and Instability. Finally, there is the Extraction Score section. The highest HSS score is 100. If the score obtained is ≥85, it is classified as 'excellent', if 70-84, as 'good', if 60-69, 'moderate', and if ≤59 as 'bad'. The validity and reliability study of the Turkish version of the HSS Knee Scoring was carried out in patients who underwent TKA at least 6 months ago and were able to act independently (17).

Pain

The Visual Analogue Scale (VAS) was used to assess preoperative pain severity. Verbal or numerical scales with measurement grades of 0-10 are often used in an objective evaluation of pain, which is a VAS subjective complaint. Intervals for pain severity are <3 mild pain, 3-6 moderate pain, and >6 severe pain (18). The modified 0-10-point version of the VAS scale was found to be valid and reliable in patients who underwent TKA (19).

Kinesiophobia

The Tampa Kinesiophobia Scale (TKS) is an assessment survey commonly used to measure pain-related movement and fear of re-injury in patients at high risk for chronic muscular pain. The TKS has 17 items in the form of a checklist. The scale includes injury/re-injury and fear-avoidance parameters in work-related activities. A high score on the scale indicates that the person has a high kinesiophobia. Test-retest reliability of the scale was found to be excellent (20).

Anxiety and Depression

The Hospital Anxiety and Depression Scale (HADS) is a self-report scale consisting of anxiety and depression subscales. As a result of the study conducted in Türkiye, the cutoff score for the anxiety subscale is 10 and the cutting score for the depression subscale is 7. Those who score above these scores are considered at risk (21). The validity and reliability of the Turkish version of the scale were established by Aydemir et al. (22).

Physical Activity Level

The International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used to determine the preoperative physical activity level IPAQ-SF consists of 4 separate sections and 7 items and provides information on the time spent walking and in moderate and vigorous physical activities. The time spent sitting in the last 1 week is recorded separately. The level of physical activity is calculated by the Metabolic Equivalent of Task [MET] method. After doing the score calculations with the MET method of the IPAQ-SF, which we used to determine preoperative physical activity levels in our study, we divided our sample group into Inactive (<600 MET-min/wk) and Active (≥ 600 MET-min/wk) (23, 24). The validity and reliability of IPAQ-SF in Turkish was determined by Saglam et al.(25).

Body Awareness

The Turkish version of the Body Awareness Questionnaire (BAQ) was used to assess patients' body awareness. The BAQ is an 18-item questionnaire developed to determine normal or abnormal sensitivity levels towards body composition and consists of 4 subgroups, namely, changes in the prediction of body responses, sleep-wake cycle, prediction at the onset of disease, pay attention to changes and reactions in the body process. The patient is asked to rate each expression in numbers between 1 and 7 points (1 point= 'The expression used is not true to me at all.' 7 points= 'The phrase used is completely true to me.'). The score range of the questionnaire is 18-126 points. High scores from the survey indicate that the person's body sensitivity is better BAQ was developed by Shields et al. in 1989 and was validated in Turkish by Karaca (26).

Postoperative Evaluation Methods

Acute Pain

In order to evaluate pain on postoperative day 3, the Brief Pain Inventory (BPI) was used. The BPI consists of 4 items related to pain severity (severity dimension) and 7 items related to pain inhibiting the person's daily activities (obstruction dimension). The severity dimension measures the most severe, mild, average, and interview pain in the last 24 hours. Pain severity is measured using a numerical pain scale (0–10) (0= no pain, 10= worst imaginable pain). The dimension of obstruction measures the degree to which the pain the patient feels in the last 24 hours interfering with their daily activities (emotional condition, walking, deep breathing and coughing exercises, sleep, and enjoyment of life). BPI was validated in Turkish by Dicle et al.(27, 28).

Acute Physical Performance

The physical performance of the patients on postoperative day 3 was evaluated using the Timed Up and Go (TUG) Test. The TUG Test can be safely applied as an indicator of balance, walking speed, functional ability, and lower extremity strength, and is an adequate performance-based measurement method evaluating functional changes in these patients (16, 29). While the patient was sitting on a chair, he was asked to get up from the chair, walk 3 meters as fast as possible, turn around, and get back on the seat. The time spent by the patient to complete the test was recorded. Shorter test times show better physical performance (30).

Statistical analysis

The G*Power program was used to determine the number of patients. The study results of Lindberg et al. were used (11) .In the power analysis performed before the study, our sample size was determined as 64 with 1% type 1 error and 90% power. Considering the possible data loss, it was decided to include a total of 70 people for the study. Statistical analyses were performed using IBM SPSS Statistics 20.0 (SPSS, Chicago, IL, USA), with the significance level set at 0.05. In the descriptive statistics related to continuous data, mean + standard deviation (SD), median, minimum, maximum values, and percentage values are given in dashed data. The Shapiro-Wilk test was used to examine the compliance of the data with normal distribution. Spearman correlation coefficient was used to examine the relationships between measurements. The correlation coefficient between 0.2-0.29 was considered weak, while the correlation coefficient between 0.30-0.49 was considered moderate, the correlation coefficient >0.50 was considered strong (31). The appropriateness of the data to normal distribution was tested in comparison of postoperative acute pain and physical performance of those with different levels of preoperative physical activity and chronic knee pain duration. A t-test was used in data that matched normal distribution and the Mann-Whitney U test was used in non-normally distributed data.

Ethical Consideration

To conduct the study, the ethics committee approval was obtained from the Directorate of Ethics for Clinical Research at Suleyman Demirel University Faculty of Medicine (Date: March 11, 2019; Number: 39474).

RESULTS

The mean age of the patients was 66.5 ± 7.53. Other demographic information about patients is summarized in Table 1.

The relationship of patients' preoperative TKS, HADS, BAQ, and VAS results with acute pain and

Table 1. Demographic Information of The Patients (n=70)

Variables		Mean ± SD / number	%
Age (year)		66.5 ± 7.53	
Height (cm)		160.4 ± 7.44	
Weight (kg)		80.8 ± 14.18	
BMI (kg/m^2)		31.37 ± 4.96	
HSS Total Score	Opere knee	56.45 ± 12.49	
	Non-opere knee	67.12 ± 13.13	
Gender	Female	53	75.7
	Male	17	24.3
BMI classification	Normal weight	6	8.6
	Overweight	21	30
	Obese (1st grade)	25	35.7
	Obese (2nd grade)	18	25.7
Educational status	Literate	7	10
	Primary school	53	75.7
	Secondary school	9	12.9
	High school	0	0
	University	1	1.4
Continuous drug use due to chronic disease or knee pain	Yes	65	92.9
	No	5	7.1
Previous (except for knee area) case of undergoing any surgical operation	Yes	53	75.7
	No	17	24.3
Opere knee	Right	33	47,1
	Left	37	52.9
Duration of pain caused by knee pain	<6 years	31	44.3
	≥ 6 years	39	55.7
Physical activity status	Inactives	41	58.5
	Actives	29	41.5
Presence of anxiety, according to HADS		32	45.7
Presence of depression, according to HADS		16	22.8

BMI: Body mass index, n: number of patients, HSS: Hospital for Special Surgery, HADS: Hospital Anxiety and Depression Scale

physical performance after surgery is shown in Table 2.

A moderate positive correlation was found between preoperative TKS scores and the worst pain in the last 24 hours (r=0.348, p<0.05) and average pain (r=0.415, p<0.001), and a strong positive correlation was found between preoperative TKS scores and pain intensity during the interview (r=0.684, p<0.001). A weak positive correlation was identified between preoperative TKS scores and TUG test durations (r = 0.280, p <0.05).

A moderate positive correlation was found between the preoperative HADS-A (r= 0.424, p<0.05) and HADS-D (r=0.329, p<0.05) scores of the patients and the postoperative pain intensity at the time of interview. It was found that there was no correlation between the preoperative BAQ scores of the patients and the worst postoperative pain and average pain felt in the last 24 hours, pain at the time of interview and TUG test durations (p>0.05). A weak positive correlation was found between preoperative VAS scores of patients and the worst pain severity in the last 24 hours (r= 0.259, p<0.05).

There was a statistically significant difference between acute postoperative TUG Test durations of

Table 2. Relationship of Patients with Acute Pain and Physical Performance After Surgery of TKS, HADS, BAQ Results Before Surgery

		TKS	HADS-A	HADS-D	BAQ	VAS
Pain Severity	r	0.348	0.138	0.009	0.196	0.259
-worst pain*	p	**0.003†**	0.253	0.944	0.104	**0.030†**
-average pain*	r	0.415	0.147	0.121	0.158	0.184
	p	**0.000†**	0.224	0.319	0.193	0.128
-pain at the time of the interview	r	0.684	0.424	0.329	0.214	0.182
	p	**0.000†**	**0.000†**	**0.005†**	0.075	0.132
TUG Test (sec)	r	0.280	0.206	0.200	-0.070	0.196
	p	**0.019†**	0.087	0.097	0.567	0.103

TKS: Tampa Kinesophobia Scale, HADS-A:Hospital anxiety and depression scale anxiety sub-score, HADS-D: Hospital anxiety and depression scale depression sub-score, BAQ: Body Awareness Questionnaire, VAS: Visual Analog Scale, *: in the last 24 hours, †: p<0.05, r: Spearman Correlation, TUG Test: Timed Up and Go Test

Table 3. Comparison of Acute Pain and Physical Performance Outcomes After Surgery of Patients with Different Levels of Physical Activity Before Surgery

	Physical activity status	n	Mean ± SD	Median(Min-Max)	p
worst pain*	Inactives	41	8.22±1.40	8 (5-10)	z=-1.293
	Actives	29	7.45±2.08	8 (2-10)	p=0.196
average pain*	Inactives	41	5.88±1.20	6 (4-9)	z=-0.855
	Actives	29	5.31±1.94	5 (0-8)	p=0.392
pain at the time of the interview	Inactives	41	4.49±2.54	5 (0-9)	t=0.127
	Actives	29	4.41±2.16	4 (0-9)	p=0.899
TUG Test (sec)	Inactives	41	64.0±26.6	59 (27-175)	z=-3.841
	Actives	29	45.31±18.04	40 (21-103)	**p=0.000†**

*: in the last 24 hours, n: number of patients, TUG Test: Timed Up and Go Test, SD: Standard Deviation, †: p<0.05, P: Mann-Whitney Test

patients with preoperatively inactive and active patients (p<0.05). The TUG Test duration of inactive patients was significantly higher than that of active patients. Details are shown in Table 3.

There was a statistically significant difference between the acute postoperative average pain in the last 24 hours, pain severity at the time of the interview, and TUG Test durations between patients

Table 4. Comparison of Acute Pain and Physical Performance Outcomes After Surgery with Patients with 5 Years and Under Preoperative Knee Pain Duration (Short Pain Duration) and Patients with 6 Years or More (Long Pain Duration)

	Pain duration classification	Mean ± SD	Median (Min-Max)	p
worst pain*	short pain duration	7.52±1.99	8 (2-10)	z=-1.415 p=0.157
	long pain duration	8.21±1.47	8 (5-10)	
average pain*	short pain duration	5.16±1.73	5 (0-9)	z=-2.245 **p=0.025**
	long pain duration	6.03±1.32	6 (2-8)	
pain at the time of the interview	short pain duration	3.77±2.32	4 (0-8)	z=-2,071 **p=0.038**
	long pain duration	5.0±2.30	5 (0-9)	
TUG Test (sec)	short pain duration	51.71±26.53	48 (21-175)	z=-2,130 **p=0.033**
	long pain duration	59.87±23.58	58 (27-149)	

*: in the last 24 hours, TUG Test: Timed Up and Go Test, SD: Standard Deviation, p: Mann-Whitney Test, p<0.05.

with preoperative knee pain duration of 5 years and under and patients with 6 years or more ($p<0.05$). Patients with preoperative knee pain duration of 6 years or more have significantly higher acute postoperative mean pain and pain intensity at the time of the interview. Details are shown in Table 4.

DISCUSSION

The results of our study provide valuable information in identifying the factors that cause delayed healing in the acute period after TKA. In this study, which was planned to determine the role of preoperative factors in acute pain and physical performance after TKA, postoperative acute pain was found to be related to kinesiophobia, anxiety, depression and pain intensity at interview, while postoperative acute physical performance was found to be related to preoperative kinesiophobia. In our study, a significant difference was found between the 'inactive' and 'active' groups in terms of acute postoperative physical performance. Similarly, it has been found that patients who previously received a preoperative exercise programme showed faster physical and functional recovery after surgery (32). Activity levels of patients can be increased with preoperative exercise programmes. Thus, postoperative pain levels and functional parameters of the patients may improve more in the postoperative period and the duration of hospital stay may be reduced.

Psychological factors play an important role in patient pain perception, rehabilitation compliance and patient outcomes, particularly in procedures requiring comprehensive rehabilitation such as total joint arthroplasty (33). In our study, a moderately significant relationship was observed between preoperative kinesiophobia and postoperative acute pain. Additionally, fear of movement was found to potentially have a negative impact on patients' postoperative physical function and recovery process. These findings highlight the necessity of considering psychological factors in postoperative pain management and functional recovery. In particular, assessing psychological factors such as kinesiophobia, which may limit movement, could contribute to a more effective rehabilitation process.

Post-TKA walking function shows significant improvement compared to pre-TKA values (34). In our study, it was observed that the increased fear of movement negatively affected patients' walking speed and that the time required to complete a safe walking distance increased due to reduced mobility. To enhance postoperative mobility, it is essential to thoroughly examine the factors that may influence physical performance. A systematic review highlights the significant role of psychological factors as preoperative predictors of improvements in pain intensity and physical function after TKA. This study supports the growing body of literature demonstrating the prognostic value of psychological factors in recovery outcomes (7). In this study, preoperative anxiety was found to be associated with postoperative acute pain and anxiety. However, since this study only examined associations, it is not appropriate to make direct generalizations about the effects of preoperative anxiety on postoperative pain management. Nevertheless, the literature suggests that changes in anxiety levels during the postoperative period may play a significant role in pain development. In this context, it is suggested that providing psychological support in the preoperative period may contribute to postoperative pain management and functional recovery (15, 35, 36).

However, in our study, no relationship was found between preoperative anxiety and depression and acute postoperative physical performance. In this study, anxiety scores of 58% and depression scores of 61% of patients with TKA were above the threshold value. In our study, this rate was 45% for anxiety and 22% for depression. Contrary to previous results, we believe that the lack of association between anxiety and depression and physical performance may be due to fewer patients showing symptoms of anxiety and depression above the threshold in the sample group in our study.

Patients with psychological problems such as anxiety, depression and kinesiophobia should be identified before surgery to prevent poor rehabilitation and surgical outcomes. In addition, early recognition and reduction of kinesiophobia may reduce the behaviour of avoiding physical activity due to pain. It may prevent the vicious cycle of pain-disability-pain that seems likely to occur in the future after surgery.

There exists no study in the literature evaluating body awareness in patients who underwent TKA. Erden et al. reported that pain and emotional condition in healthy people affect body awareness indirectly. It was found that patients who have good ability to identify the body and perceive the sensory, physiological, and physical stimulations of the body, that is, those with high body awareness, have reduced pain and less frequent depressive symptoms (37). In our study, no association was found between preoperative body awareness and acute postoperative pain and physical performance.

There are a limited number of standardized tools in Turkish for assessing body awareness. Although the BAQ demonstrates high validity and reliability, it assesses body awareness in a unidimensional manner and does not include components specifically associated with pain perception. This limitation may have contributed to the inability to detect a relationship between body awareness, pain, and physical performance. Additionally, considering that body awareness may vary in the postoperative period, the fact that our study assessed it only in the acute postoperative phase and did not examine its long-term effects may have contributed to the lack of an observed relationship. Furthermore, it has been noted that this questionnaire omits certain fundamental domains that could potentially capture both adaptive and maladaptive aspects of body awareness (38). This study also draws attention to the lack of this field in the literature.

Dash et al. investigated the relationship between preoperative walking ability and functional outcome and quality of life after TKA. They concluded that patients with an active preoperative lifestyle and good walking ability had significant improvements in functional ability in the early and late postoperative periods compared with patients with a sedentary lifestyle and poor walking ability (39).

In our study, patients who were inactive before surgery (41 patients) had significantly worse acute postoperative physical performance than active patients (29 patients). The reason for 58.5% of patients having an inactive lifestyle may be OA-related pain, which is the primary indication for TKA. As 55.7% of the patients were known to have had knee pain for more than 6 years, it is possible that they adopted a sedentary lifestyle due to pain.

Patients with chronic knee pain for longer periods of time have higher complication rates (40). Based on this information, we divided the patients based on preoperative chronic pain duration as '<6 years' (31 patients) and '≥ 6 years' (39 patients). The patient group with preoperative chronic pain duration of 6 years or more showed worse acute postoperative pain and physical performance results compared to the other group. Complications that develop after TKA and delays in functional improvements will increase the rate of hospital admission, which affects the success rate of TKA. Complications and early hospital admission rates are important in determining the success of TKA; therefore, as part of the strategy to prevent post-TKA complications, preoperative knee pain duration should also be taken into account.

In summary, modifiable preoperative factors were found to be associated with acute postoperative pain and physical performance in patients who underwent total knee arthroplasty. These results may be useful in designing interventions aimed at improving postoperative pain and physical performance.

Study Limitations and Future Perspective

The strength of our study is that it is the only study to comprehensively examine modifiable preoperative factors associated with acute postoperative pain and physical performance in patients undergoing TKA. However, due to the unequal gender distribution in the study sample and the inclusion criteria, the results cannot be generalized to all TKA patients. Additionally, the fact that surgical procedures were performed by different surgeons and that the dominance of the operated limb was not considered are other limitations of our study. Future studies should take into account limb dominance and the impact of surgical procedures on study outcomes. To minimize this effect, surgical procedures should be standardized. By using a larger sample size and a broader age range, the findings of studies can be generalized to a wider population. It is believed that this study may contribute to further research in the relevant field.

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Çağlayan Pınar ÖZTÜRK, PhD[1]
Ferdi BASKURT, Prof[2]
Zeliha BASKURT, Prof[3]

1 Süleyman Demirel Üniversitesi Doğu Kampüsü Isparta Sağlık Hizmetleri MYO Merkez/Isparta
2 Süleyman Demirel Üniversitesi Doğu Kampüsü Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon Bölümü Merkez/Isparta
3 Süleyman Demirel Üniversitesi Doğu Kampüsü Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon Bölümü Merkez/Isparta

Correspondence (İletişim):

Çağlayan Pınar ÖZTÜRK
Süleyman Demirel Üniversitesi Doğu Kampüsü
Isparta Sağlık Hizmetleri MYO Merkez/Isparta
caglayanozturk@sdu.edu.tr
ORCID: 0000-0002-7049-9746

Ferdi BASKURT
ferdibaskurt@sdu.edu.tr
ORCID: 0000 -0002-8997-4172

Zeliha BASKURT
zelihabaskurt@sdu.edu.tr
ORCID: 0000-0001-7488-9242

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BIBLIOMETRIC ANALYSIS OF PUBLICATIONS IN THE FIELD OF PHYSIOTHERAPY IN TÜRKİYE

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study is to perform a bibliometric analysis of publications in the field of physiotherapy based in Türkiye.

Methods: The study included all publications in the field of physiotherapy between 1988-20024, published or accepted for publication in various international journals related to Türkiye. The publications included in the bibliometric analysis were accessed using the Web of Science (WoS) Core Collection. To access the publications, the keywords physical therapy, physiotherapy, physical rehabilitation and manual therapy were typed into the advanced search tab of the WoS Core Collection. Turkey and Türkiye were selected as the region/country filter and English was selected as the language filter. "RStudio/Biblioshiny" and "Vosviewer" software were used for analysis and visualization.

Results: The analysis revealed a total of 5,511 publications in the field of physiotherapy from Türkiye between 1988 and 2024. The university most affiliated with publications was Hacettepe University and the main funder was TÜBİTAK. Recently, there were trend topics like chemotherapy, muscle activation, COVID-19, quality of life, postural control, validity and reliability. In addition, when cross-country collaboration was analyzed, it was observed that researchers in Türkiye mostly collaborated with researchers in Europe and the Balkans, and that the countries of collaboration have changed recently

Conclusion: As a result of the analysis, it was determined that the annual publication increase rate of Türkiye-based publications in the field of physiotherapy was 12.82% and the number of publications in the last ten years -especially after 2016- has accelerated.

Keywords: Bibliometric analysis, Physiotherapy, Manual Therapy

TÜRKİYE'DE FİZYOTERAPİ ALANINDA YAPILMIŞ YAYINLARIN BİBLİYOMETRİK ANALİZİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı, Türkiye merkezli fizyoterapi alanında yapılmış yayınların bibliyometrik analizini gerçekleştirmektir.

Yöntem: Çalışma, 1988-20024 yılları arasında fizyoterapi alanında yapılmş, Türkiye ile ilişkili, çeşitli uluslararası dergilerde yayınlanan veya yayınlanması kabul edilen tüm yayınları kapsamaktadır. Bibliyometrik analize dahil edilen yayınlara Web of Science (WoS) Core Collection kullanılarak erişilmiştir. Yayınlara erişim için WoS Core Collection'ın gelişmiş arama sekmesine; fizik tedavi, fizyoterapi, fiziksel rehabilitasyon ve manuel terapi anahtar kelimeleri yazılmıştır. Bölge/ülke filtresi olarak Turkey ve Türkiye, dil filtresi olarak İngilizce seçilmiştir. Analiz ve görselleştirme için "RStudio/Biblioshiny" ve "Vosviewer" yazılımları kullanılmıştır.

Sonuçlar: Analiz sonucunda, 1988 ile 2024 yılları arasında Türkiye'den fizyoterapi alanında toplam 5.511 yayın olduğu tespit edilmiştir. Yayınlarla en ilişkili üniversitenin Hacettepe Üniversitesi olduğu ve başlıca fon kaynağının TÜBİTAK olduğu görülmüştür. Son dönemde kemoterapi, kas aktivasyonu, COVID-19, yaşam kalitesi, postüral kontrol, geçerlilik ve güvenilirlik konularına doğru bir yönelim olduğu belirlenmiştir. Ayrıca, ülkeler arası iş birliği incelendiğinde, Türkiye'deki araştırmacıların çoğunlukla Avrupa ve Balkanlar'daki araştırmacılarla iş birliği yaptığı ve son dönemde iş birliği yapılan ülkelerin değiştiği görülmüştür.

Tartışma: Analiz sonucunda fizyoterapi alanında Türkiye merkezli yayınların yıllık yayın artış oranının %12,82 olduğu ve son on yılda yayın sayısının -özellikle 2016 yılından sonra- ivme kazanarak arttığı belirlenmiştir.

Anahtar Kelimeler: Bibliyometrik analiz, Fizyoterapi, Manuel Terapi

INTRODUCTION

According to the World Confederation of Physiotherapy (WCPT), physiotherapy includes services provided by physiotherapists to individuals and communities to increase mobility and improve functional ability throughout life. Physiotherapists are health professionals with roles in promotion, prevention, treatment/intervention, and rehabilitation to improve quality of life and functionality. It is accepted that physiotherapists have some skills such as examining the clients, determining their needs, formulating the diagnosis, recommending the client to another specialist if necessary, applying treatment and training programs, and evaluating the results. Physiotherapists collaborate with other health professionals to achieve their goals. The field of physiotherapists is not limited to the patient/client. They can develop strategies for public health and manage national and international projects (1-3). Physiotherapists, also known as physical therapists, are highly skilled health professionals trained in a variety of fields with a role in the treatment of both mental and physical illnesses (4).

In Türkiye, the first Department of Physiotherapy and Rehabilitation has been opened in 1961 at Hacettepe University. This department alone had trained physiotherapists for 25 years. Turkish Physiotherapists Association was the first physiotherapy association founded in 1969 and became a member of WCPT in 1974 and WCPT-Europe in 1991 (5). Specialty groups of World Physiotherapy are acupuncture, cardiorespiratory, electrophysical, HIV/AIDS, oncology, hospice and palliative care, mental health, occupational health and ergonomics, pediatrics, private practice, sports, pelvic and women's health, older people, neurology, manual/musculoskeletal physiotherapy and aquatic (6).

In a study conducted on student profiles of physiotherapy departments in Türkiye, it was seen that there was a total of 100 faculties and 6 colleges with physiotherapy programs. When the universities with departments were analyzed, it was found that 53 of them were state universities and 46 of them were within the faculty of health sciences, 4 of them were physiotherapy/physical therapy and rehabilitation faculties and 3 of them were colleges (7). When postgraduate education was compared with the examples of European countries, it was seen that the number of postgraduate programs opened was not sufficient compared to the number of graduates (8).

Although orthopedics has been the first specialization area of physiotherapists, chest physiotherapy, cardiac rehabilitation, neurological rehabilitation, hand rehabilitation and physiotherapy in sports have been the first developing branches. Considering postgraduate studies in the field, in a bibliometric study on doctoral theses, it was reported that most publications made in the field of orthopedic physiotherapy (30.3%), general physiotherapy (23.2%) and pediatric physiotherapy (16.8%), respectively (9).

Bibliometric analysis, which is the method used in this study, is an analysis method used to evaluate publications, funders, universities, journals, trending topics, keywords, authors and countries, as well as the collaborations among authors and among countries in any field and to observe the intellectual, social and conceptual structure. With the use of this method, the problem of the rapid increase in the number of data can be overcome that a subject cannot be followed by traditional research methods (10).

In the field of physiotherapy, bibliometric studies are used to reveal the thematic structure and development of publications worldwide, to identify the main producers of research (i.e. countries and institutions), to compare research outputs and citation impacts, and to determine the trends of researchers periodically. These studies objectively have provided a perspective for researchers in the field (11,12). Apart from this, bibliometric analysis offers the opportunity to discover important researchers, journals, institutes in the field regionally and worldwide by examining publications on a specific topic in the field of physiotherapy (13,14). In a previous bibliometric study on publications in the field of physiotherapy, it has indicated that between 1986 and 2017, especially "neurological rehabilitation, methods, exercise for the prevention and rehabilitation of lifestyle diseases, assessment and treatment of musculoskeletal pain, physical

activity, health promotion and behavior change, respiratory physical therapy, hospital primary care and health economics, cancer and complementary therapies" are worldwide trend topics (15). In another study on the subject, between 2000-2018, the studies in the field of physiotherapy around the world have analyzed and "health care and education, biomechanics, psychosocial, chronic pain and quality of life outcomes, evidence-based physical therapy research methods, traumatology and orthopedics, neurological rehabilitation, psychometrics and cross-cultural adaptation, gait-balance analysis and Parkinson's disease, exercise, respiratory physical therapy, back pain" were trend topics (11).

The use of RStudio/Biblioshiny and Vosviewer in bibliometric analysis has increased in recent years. While the R program provides users with the opportunity to look at the current literature from different aspects provides to its wide analysis capabilities, Vosviewer helps researchers with its visualization capability.

The aim of this study is to evaluate the development of Türkiye-based publications in the field of physiotherapy over time. In this context, publications in the field between 1988 and 2024 were analyzed by downloading the publications from the WoS Core Collection. The most relevant universities, the most relevant researchers, the most frequently used funders, the most cited and most citing publications, the most frequently used words, the trending topics and the collaborations of researchers and countries have evaluated and presented in an understandable way with visuals and graphics.

METHODS

The aim of this research is to conduct a bibliometric analysis of Turkish-based physiotherapy publications listed in the WoS Core Collection, whether already published or accepted for publication. WoS Core Collection was used in this study because it is a comprehensive database indexing more than 20,000 mainstream scientific journals by Clarivate Analytics (16,17). The keywords "Physical Therapy, Physiotherapy, Physio Therapy, Physical Rehabilitation, and Manual Therapy" (as the presence of any one of these keywords was sufficient, they were included in the search code using "or") were used to identify publications in the field of physiotherapy, while "Turkey and Türkiye" (as the presence of any one of these keywords was sufficient, they were included in the search code using "or") were used

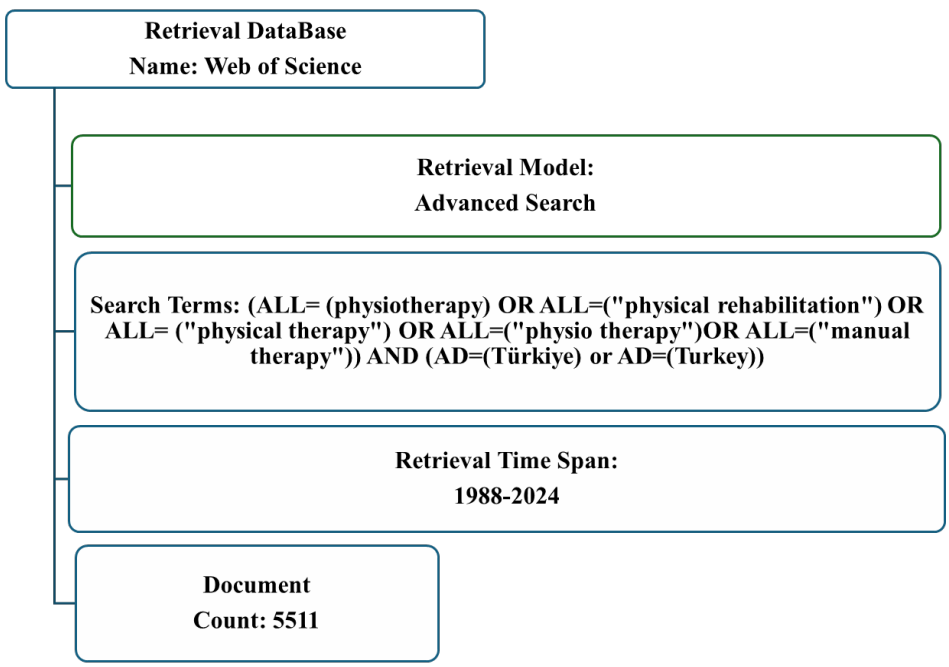

Figure 1. Data Source and Research Method

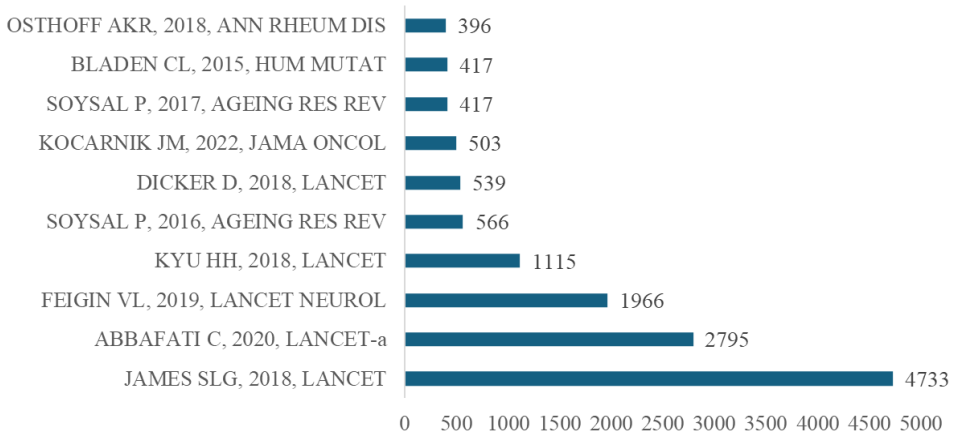

Figure 9. Most Global Cited Documents

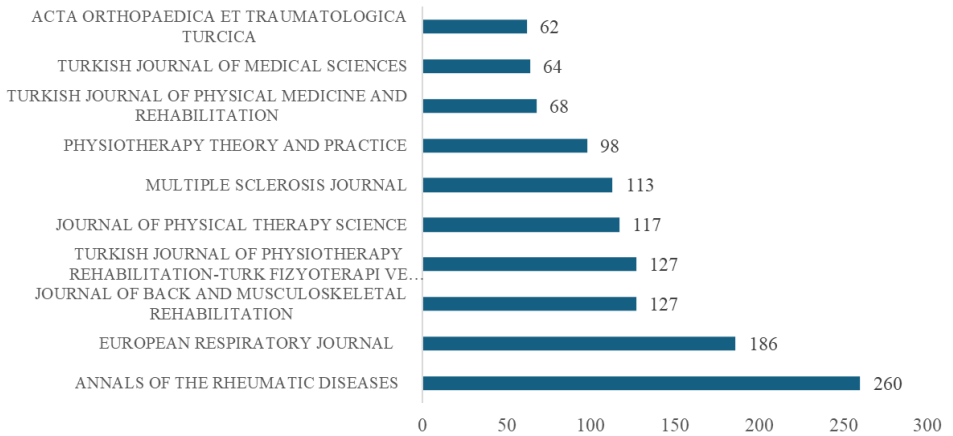

Figure 10. Most Relevant Sources

to filter the relevant publications by country. In the search code, the word "and" was used to identify both publications in the field of physiotherapy and publications related to Türkiye. No year limitation was made during the search. Only English-language publications were included the analysis (18). Data was downloaded on February 16, 2024 (Figure 1). The study was conducted by downloading the publications on this date and analyzing the data within a one-month period using the software tools described below.

Data analysis: In this study, the R Studio (K-Synth Team, Italy) (19) was used for bibliometric analyses and the analyses were reported and visualized using the Shinny interface and Vosviewer software (Vosviewer version 1.6.20, Leiden University's Centre for Science and Technology Studies (CWTS), Leiden, The Netherlands) (20). Using this method, it is possible to analyze publications in a field in terms of key aspects such as the most relevant authors, affiliated institutions and funders, the most cited publications and authors, frequently referenced journals, commonly used keywords, trending topics, collaboration clusters among researchers, and international collaborations etc. In addition, the types and number of publications, citations, and their development over time can also be reported.

The inclusion criteria for this study were i) to be in the field of physiotherapy, ii) to be related to Turkey or Türkiye, and iii) to be conducted in English. Within the framework of these criteria, no publications were excluded from the publications downloaded from WoS Core Collection on March 16, 2024.

Since the purpose of this study is to examine documents related to the field, ethics committee permission is not required.

RESULTS

In this study, when the publications related to Turkey were examined without year and language limits, it was seen that the first publications in the field of physiotherapy started to be made since 1988 and a total of 5,919 publications were made. 5.511 of which were published in English, 401 in Turkish and 7 in different languages. When the curve of the number of publications is analyzed in the graph, it is understood that the change started in 2008, accelerated after 2014 and showed a concave increase as of 2016 (Appendix, Figure 2).

The bibliometric analysis of the publications in the field of physiotherapy in Türkiye showed that the annual number of publications increased gradually until the end of 2023 (The average for 2024 wasn't not known as it is not finished yet).

When the main information of the available data were examined, It was seen that the total number of sources for publications was 1196, average annual publication increase was 12.82%, the average document age was 5.64, the average annual citation rate was 10.13, the total number of references was 116454, keywords plus (keywords generated by Web of Science from the titles of cited references) were 6278, the total number of author's keywords was 7889, the total number of authors was 18556, the number of single-author documents was only 121, co-authors per document were 7.5 and international co-authorships was 10.72% (Appendix, Table 1).When the types of publications were analyzed, most of all publications were articles (75%), followed by meeting abstracts and reviews (Appendix, Table 2).

When the institutions related with the publications produced were examined, it was determined Hacettepe University was the most affiliated institute, while Dokuz Eylül and Gazi University followed 2nd and 3rd. 44.6% of total publications were affiliated with Hacettepe University (Appendix, Figure 3).

The number of publications affiliated with Hacettepe University had increased more than those of other institutions over the years, gained significant momentum after 2013 (Appendix, Figure 4).

When the institutions that funded the publications were analyzed, it was found that TÜBİTAK funded the most publications, followed by US-based organizations ranking second and third (Appendix, Figure 5).

The rate of increase in publications accelerated after 2016. But the citation average was not parallel to it. The highest publication citation average was in 2018 (Appendix, Figure 6).

When the countries of the cited publications were evaluated, it was seen that the most cited country was Türkiye. The authors of the sources in the dataset used in this analysis cite mostly Türkiye-based studies and secondly USA-based studies (Appendix, Figure 7).

When the most cited documents were evaluated, it was founded that, the most local cited article was "Validation of the Turkish Version of the Oswestry Disability Index for Patients with Low Back Pain" by Yakut E. et al. published in the Spine. This result refers to the most cited documents in the downloaded data. In addition, the graph below shows how many citations this publication has received both within the downloaded data set and worldwide, so it is clear how much attention this publication has received worldwide (Appendix, Figure 8). Information on these publications has been given as a table in the appendix section (Appendix, Table 3)

The article with the highest international citations was the one published in Lancet by James SLG (Figure 9). The result obtained in this analysis represents the document with the highest citations, whether included or not in this dataset. The most global cited publications of Turkish researchers have been given in the table (Appendix Table 4).

When the journals with the highest number of publications related to Türkiye were evaluated, Annals of The Rheumatic Health ranked first. European Respiratory Journal became the second journal, and Journal of Back and Musculoskeletal Rehabilitation became the third journal (Figure 10).

This list (Figure 10) shows the journals with the largest number of publications, not the journals most frequently referenced for publications. When we examined the most cited journals in the downloaded data set, Arch Phys Med Rehab, Phys Ther and Spine were the top 3 journals, respectively. The list of most cited sources refers to the most ef-

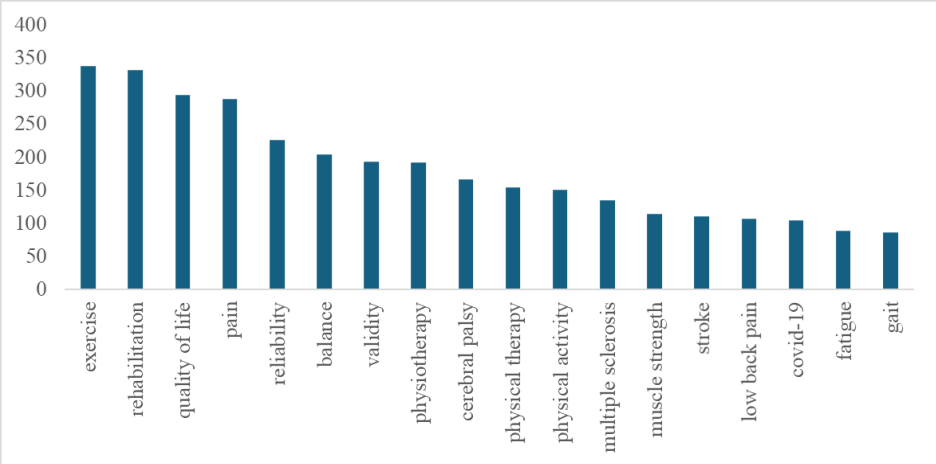

Figure 16. Most Frequent Author's Keywords (Most Frequent 20 Words)

ficient sources in the development of the field of physiotherapy in Türkiye (Appendix, Figure 11).

The term "most local cited documents" refers to the most cited documents or papers on a particular topic. These documents can often be research papers, reports or other written material and represent the most cited sources on the topic. This data refers to the author with the highest number of citations (within the uploaded dataset) in Türkiye-based publications for this publication. When the data on the most local cited authors locally were evaluated, it was seen that Kırdı N. was the most local cited author, followed by Fırat T. and Kiraz S. (Appendix, Figure 12).

The term "most relevant author" does not indicate the author with the highest number of publications. Instead, it refers to the author who is most closely associated with the content, context, or subject of the paper, or who has made the most significant contribution to the research. Kahraman T. was found to be the most relevant author in the publications, followed by Baltacı G. and Tarakçı E. (Appendix, Figure 13).

When the productivity of the authors over the years was analyzed, it was determined that Baltacı G. was the author who produced the most over the years. The lines in the graph indicate that the authors continue to publish. The larger the dots indicate that the number of publications of the authors increase, and the darker the dots indicate that the average number of citations of the authors increase (Appendix, Figure 14).

The term "most local cited references" refers to the most cited references on a given topic. These references represent the most important and prominent sources on the topic, often used in research papers. "Most local cited documents" refers to the documents themselves, while "Most local cited references" refers to the references used in the documents (Appendix, Figure 15).

Most frequent words

When the authors' 20 most frequently used keywords in the publications were questioned, it was seen that exercise, rehabilitation, quality of life, reliability, balance, and validity were the most frequently used words, respectively (Figure 16).

The word cloud created with the 50 most used key words has been given below. The size of the words in the word cloud indicates the frequency of use (Appendix, Figure 17).

If the authors' keywords are expressed in different colors by year and in different sizes according to the frequency of use, the flow of keywords in the publications can be more clearly understood. The keywords changed to tele-rehabilitation and telehealth towards 2022, and these two words were associated with the words fatigue, COVID-19, quality of life, physiotherapy, and exercise. In retrospect, it was seen that the keywords used by the authors over the years changed over time, meaning that new topics of study emerged, and the focus of the researchers changed (Appendix, Figure 18).

The change in the use of terms in the field over the

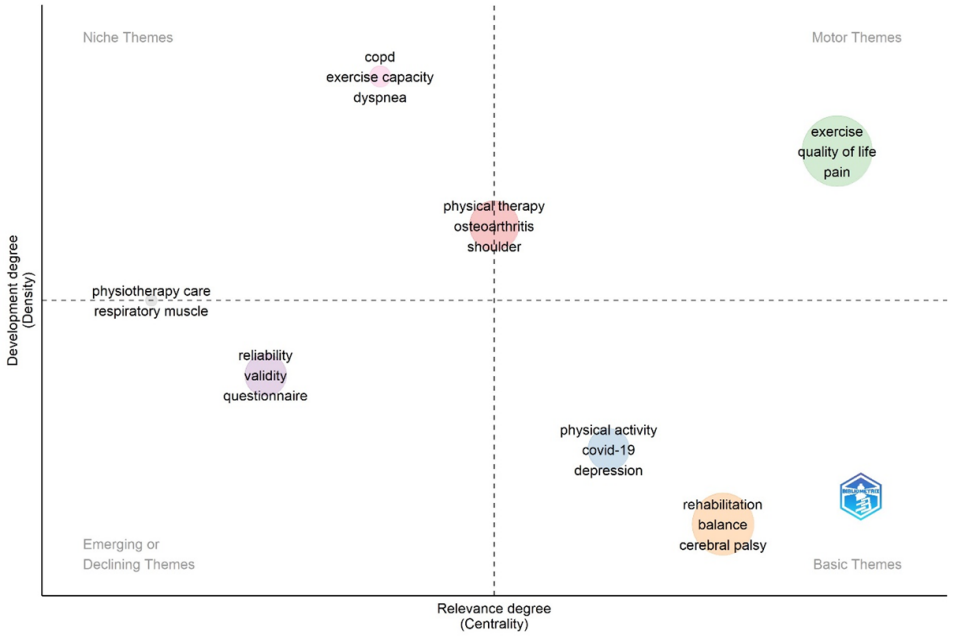

Figure 20. Thematic Map in Publications in The Field of Physiotherapy in Türkiye

years can be observed with trending topics analyses (21). When trending topics were analyzed (using keywords identified by the authors), it was seen that the topics studied by the authors changed over time. According to this graph, researchers recently focused on chemotherapy, muscle activation, COVID-19, quality of life, and postural control. Activity questionnaires, validity and reliability were also frequently used words. For a more detailed understanding, the graph has been showing the subjects studied by year can be examined (Appendix, Figure 19).

Thematic Map

Thematic maps are used to identify emerging topics, developing and stable research topics, and topics of declining interest in a field. In a thematic map, the position of the topic indicates its status in the field of publications. The themes in the upper right quadrant are both well developed and basic topics for a field. These are known as the motor-themes of the specialty because they provide strong centrality and high density. The positioning of themes in this quadrant implies that they are externally related to other themes that are conceptually closely connected. The themes in the upper left quadrant have well-developed internal relationships but insignificant external relationships and are therefore of marginal importance for the domain. These themes are highly specialized and peripheral. Themes in the lower-left quadrant are both weakly developed and marginal. Themes in this quadrant have low intensity and low centrality, typically representing emerging or disappearing themes. Themes in the lower-right quadrant are important for a research field but are not developed. Therefore, this quadrant groups transversal and general, basic themes (22).

In the field of physiotherapy for the period of analysis, topics such as exercise, quality of life, and pain were developing. Topics such as COPD, exercise capacity, and dyspnea require specialization and were also developing. Validity, reliability, and scale development represented emerging topics. Topics such as physical activity, COVID-19, depression, rehabilitation, balance, and cerebral palsy were basic but not developing. The development of the field was towards exercise, pain, and quality of life. The field of pulmonary rehabilitation continued to specialize and develop. The size of nodes representing the topics is associated with the number of publications (Figure 20).

The setting used in the program: number of words-250, number of labels-3, label size 0.3, mini cluster frequency (per thousand docs) 5, mini weight index 0.1, clustering algorithm walktrap/R Biblioshiny.

Thematic Evolution

Thematic evolution refers to the analysis made about the change, transformation or development of a subject or field over time. The thematic evaluation was made before and after 2016 when the number of publications increased particularly rapidly.

When examining the thematic map before 2016, it was observed that studies related to the spinal cord represented a specialized and developing area, while topics such as knee and osteoarthritis represented developing areas. Rehabilitation, physical therapy, exercise, cerebral palsy, and balance topics, along with validity and reliability studies, did not represent foundational yet non-developing areas (Appendix, Figure 21).

The setting used in the program: number of words-250, number of labels-3, label size 0.3, mini cluster frequency (per thousand docs) 5, mini weight index 0.1, clustering algorithm walk trap/R Biblioshiny.

After 2016, dysphagia emerged as a specialized and developing topic. Additionally, studies related to respiratory muscles determined as a newly emerging area after 2016. It was noticed that the development of topics such as exercise, pain, and physiotherapy were on the rise (Appendix, Figure 22).

Co-Occurrence/Co-Word Analysis

Through co-occurrence/co-word analysis, the relationship and clustering of authors in the network in a field is determined. Visualizing the state of the network, elements of the same color indicate clusters, and the size of the nodes indicates the frequency of the terms. In addition, the closer the words are in clusters, the more they appear together (21,23). Co-word analysis of the keywords used by the authors showed that exercise, rehabilitation, quality of life, reliability, validity, pain and balance were the words most frequently used by the authors together (Appendix, Figure 23).

Co-authorship of Authors

It is preferred to analyze the structure of collaborations of authors in a field. It is also used to determine the status of an author (24). Although this analysis provides only a partial picture of collaborations in a field, it seems to be one of the most effective methods (25). When the co-authorship analysis was visualized, it was seen that the collaboration strength of the authors changed over the years according to the colors and new authors increased their collaboration strength (Appendix, Figure 24).

The authors who produced the most publications in the field of physiotherapy in Türkiye (Sağlam M. with 110 publications, Kahraman T. with 99 publications, İnal-İnce D. with 93 publications, respectively) and the authors who received the most citations (Soysal Pınar with 1568 citations, Baltacı G. with 1486 citations, Çelik Derya with 669 citations,) were not the same person (During the co-authorship analysis, a minimum of 10 publications and 10 citations per author were restricted, and a total of 317 strong relationships were found by Vosviewer, therefore publications that do not meet this requirement eliminated.).

International Collaboration

Collaboration between countries is used to reveal the collaboration between authors from different countries (25). When cross-country collaboration was examined for Türkiye, it was observed that there was a strong collaboration with a total of 66 countries with at least 5 publications and at least 5 citation restrictions in Vosviewer before visualization. The most collaborating countries with Türkiye were USA, UK, Italy, Spain and Belgium, respectively. When the international collaboration status of researchers in Türkiye was analyzed, it was seen that although they had collaborations with countries in different locations such as Canada, Argentina, Brazil, Japan, Australia, New Zealand, China and Nigeria, their collaborations were mostly limited to their own geographical regions. Europe and the Balkans emerged as areas of closer collaboration. New collaborations between researchers in Türkiye and countries such as Saudi Arabia, Pakistan, Qatar, Jordan, Nigeria, Bangladesh, Bangladesh, Indonesia, Libya, Kazakhstan and Ukraine were also observed. Finally, the term “Türkiye” has started to be used instead of “Turkey” in recent publications (Figure 25).

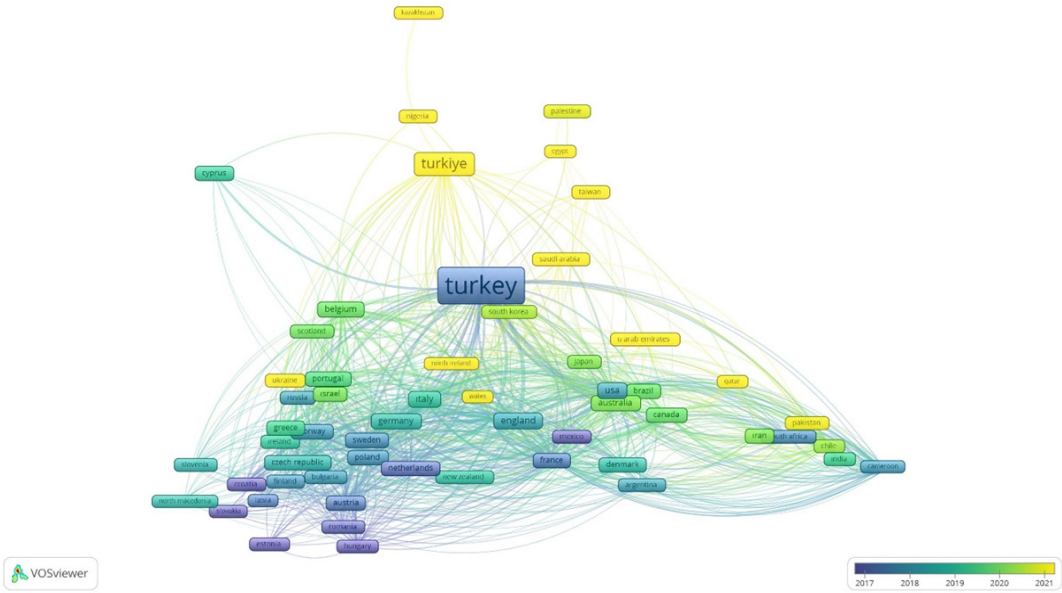

Figure 25. Countries' Collaboration World Map

DISCUSSION

In this study, a bibliometric analysis was conducted to evaluate the development of the field of physiotherapy in Turkey. According to WoS Core Collection data, 5,511 publications were made in the field of physiotherapy based in Türkiye between 1988 and 2024, with an annual increase of 12.82%. Hacettepe University was most affiliated with publications and TÜBİTAK was the main funder. Recently, there was an increased focus on topics such as chemotherapy, muscle activation and COVID-19. Researchers collaborated especially with Europe and the Balkans. The number of publications in Türkiye accelerated especially after 2016, which may have been related to the increasing number of researchers in parallel with increasing number of physiotherapy programs in universities.

The fact that Hacettepe University was the university most affiliated with Türkiye-based publications was expected since it was the oldest university where the physiotherapy department was opened. It was also observed that the gap between the number of publications affiliated with Hacettepe University and the number of publications affiliated with other universities has gradually widened over the years. This shows that Hacettepe University maintained its dominance in the affiliation with publications. The fact that Gazi University (2008) and İzmir Katip Çelebi University (2011) entered the top 5 in the number of affiliated publications even though the physiotherapy and rehabilitation departments have opened quite late compared to the others, it can be interpreted that these two universities are successful in terms of academic publications. It is also remarkable that universities from neighboring regions did not make it into the ranking. When this situation is evaluated in terms of high-quality academic publications, it can be considered that the level of development was not sufficient for neighboring universities.

According to the results of the analysis, although the number of publications in Türkiye increased in last ten years, the average number of international citations did not exceed 2018. Since the publications analyzed were from WoS Core Collection database, it can be thought that this may not be related to publication quality, but to the preferred topics or the ability of our publications to lead the literature. Researchers in Türkiye most frequently cited publications from Türkiye, followed by the United State. It can be predicted that Turkish sources were preferred because they were easier to read and understand. This may be a factor that reduces the chances of benefiting from international resources.

It was seen that the keywords preferred in publications changed over time. In particular, the fact that

the publications in the COVID-19 period were related to tele-health and tele-rehabilitation, as well as topics such as pain, fatigue, and quality of life were parallel to the international flow of academic publications. This shows that researchers followed the general trend in the world in COVİD-19 period. In addition, muscle activation, chemotherapy and postural control recently became trending topics in the field of physiotherapy.

The fact that the most cited publication was a scale about low back pain can be explained by the fact that especially publications related to low back pain were made, and it can also be explained by the fact that those working on low back pain preferred this scale the most. In addition, the fact that Kırdı N. was the most cited author may be related to the fact that this researcher is a co-author on the scale related to low back pain and has many publications on electrotherapy, which is used in many different specialty groups in physiotherapy.

The journals in which the submitted publications are most accepted and published may increase awareness among researchers in terms of preference. The most cited journals can answer the question "What is the source that researchers in Türkiye benefit from?".

The results of the analysis, especially multi-authorship in publications, drew attention. This can be explained as a high level of collaboration in publications. When the intellectual structure was evaluated, it could be stated that there was clustering among the authors, which indicates specialization in some fields.

This study has some limitations. First, the publications analyzed were in English, which led to the neglect of publications in other languages. Secondly, the fact that only WoS Core Collection was used as a database to download publications and publications in other databases were not included in the evaluation means that the results cannot be generalized for all publications. For a more general evaluation of publications, it is recommended that data from different databases be combined and analyzed. On the other hand, this study offers a general perspective to researchers as the first publication to present a bibliometric analysis of publications related to Türkiye in the field of physiotherapy from past to present. It is thought that bibliometric analysis of specific topics in future publications will provide researchers with a more comprehensive perspective compared to traditional research methods.

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Conflict of Interest: There was no conflict of interest between the authors.

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APPENDIX

Table 1. Main Information

ABOUT DATA		DOCUMENT CONTENTS	
Timespan	1988:2024	Keywords Plus	6278
Sources (Journals, Books, etc)	1196	Author's Keywords	7889
Documents	5511	**AUTHORS**	
Annual Growth Rate %	12.82	Authors	18556
Document Average Age	5.64	**AUTHORS COLLABORATION**	
Average citations per doc	10.13	Single-authored docs	121
References	116454	Co-Authors per Doc	7.5
		International co-authorships	10.72%

Table 2. Types of Publications in The Field of Physiotherapy

Article	4108	Editorial material	34
Article; book chapter	14	Editorial material; book chapter	1
Article; data paper	1	Letter	55
Article; early access	191	Letter; early access	2
Article; proceedings paper	54	Meeting	1
Article; retracted publication	1	Meeting abstract	744
Correction	16	Meeting abstract; withdrawn publication	2
Correction; early access	1	Proceedings paper	50
Correction; retracted publication	1	Review	228
		Review; early access	7

Table 3. Doi Numbers of The Most Local Cited Documents

Document	DOI
YAKUT E, 2004, SPINE	10.1097/01.BRS.0000113869.13209.03
KAYA E, 2011, CLIN RHEUMATOL	10.1007/s10067-010-1475-6
UNVER B, 2005, J REHABIL MED	10.1080/16501970510035070
EINSPIELER C, 2019, J CLIN MED	10.3390/jcm8101616
AYVAT E, 2017, TURK J MED SCI	10.3906/sag-1605-7
DOGAN SK, 2008, CLIN RHEUMATOL	10.1007/s10067-007-0815-7
BENDER T, 2005, RHEUMATOL INT	10.1007/s00296-004-0487-4
KARADIBAK D, 2008, J SURG ONCOL	10.1002/jso.21035
CELENAY ST, 2012, INT UROGYNECOL J	10.1007/s00192-012-1729-8
KAYA S, 2015, INT UROGYNECOL J	10.1007/s00192-015-2786-6

Table 4. Doi Numbers of The Most Global Cited Documents

Paper	DOI
JAMES SLG, 2018, LANCET	10.1016/S0140-6736(18)32279-7
ABBAFATI C, 2020, LANCET-a	NA
FEIGIN VL, 2019, LANCET NEUROL	10.1016/S1474-4422(18)30499-X
KYU HH, 2018, LANCET	10.1016/S0140-6736(18)32335-3
SOYSAL P, 2016, AGEING RES REV	10.1016/j.arr.2016.08.006
DICKER D, 2018, LANCET	10.1016/S0140-6736(18)31891-9
KOCARNIK JM, 2022, JAMA ONCOL	10.1001/jamaoncol.2021.6987
SOYSAL P, 2017, AGEING RES REV	10.1016/j.arr.2017.03.005
BLADEN CL, 2015, HUM MUTAT	10.1002/humu.22758
OSTHOFF AKR, 2018, ANN RHEUM DIS	10.1136/annrheumdis-2018-213585

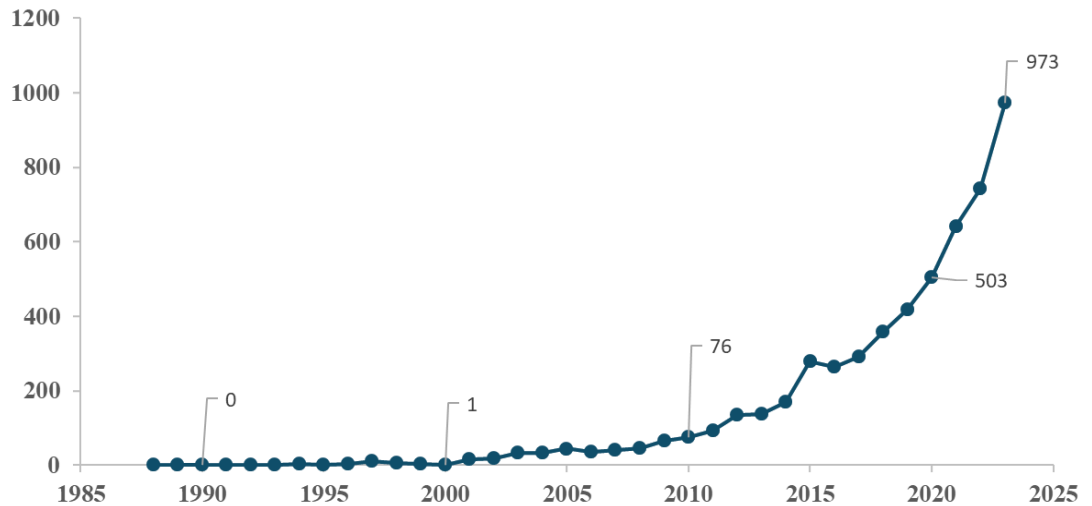

Figure 2. Number of Publications in The Field of Physiotherapy in Türkiye Over The Years

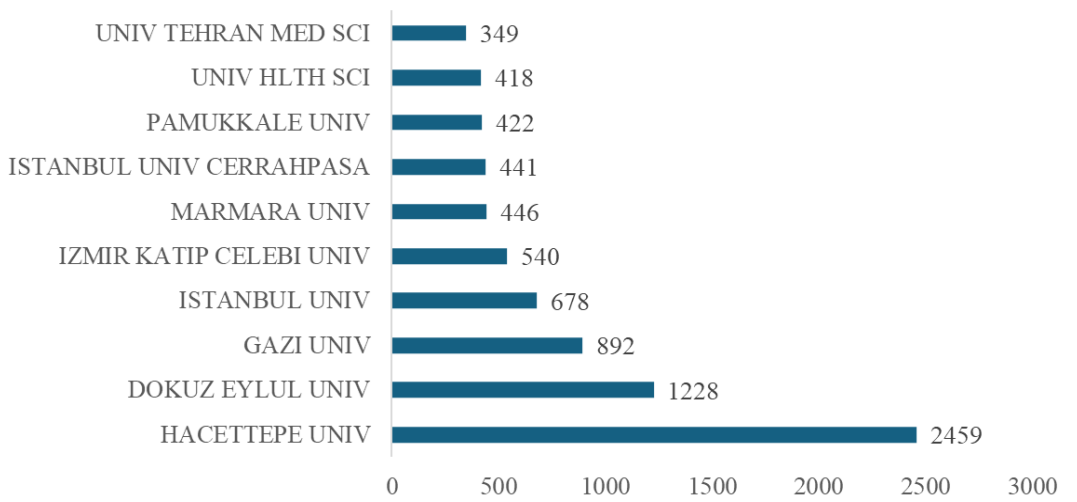

Figure 3. Most Relevant Institutes

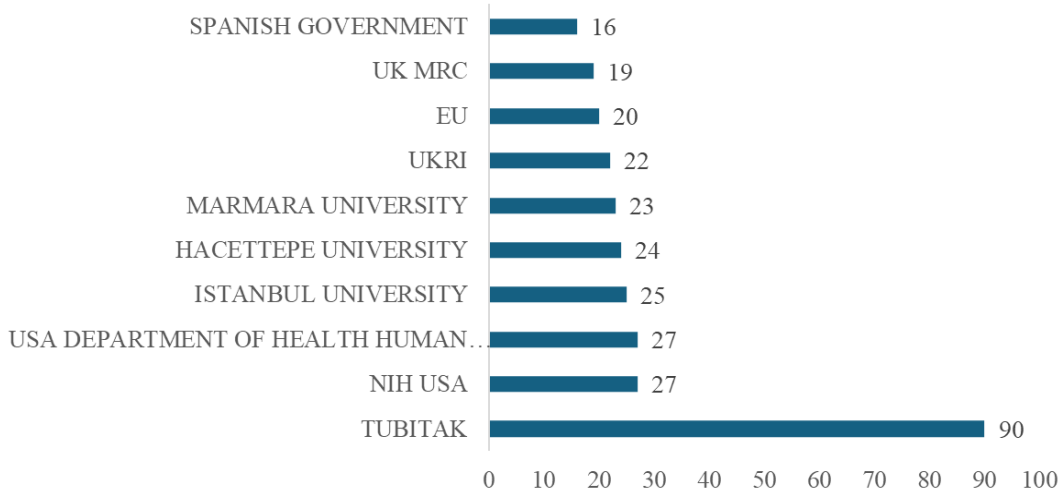

Figure 4. Funding Agencies for Publications

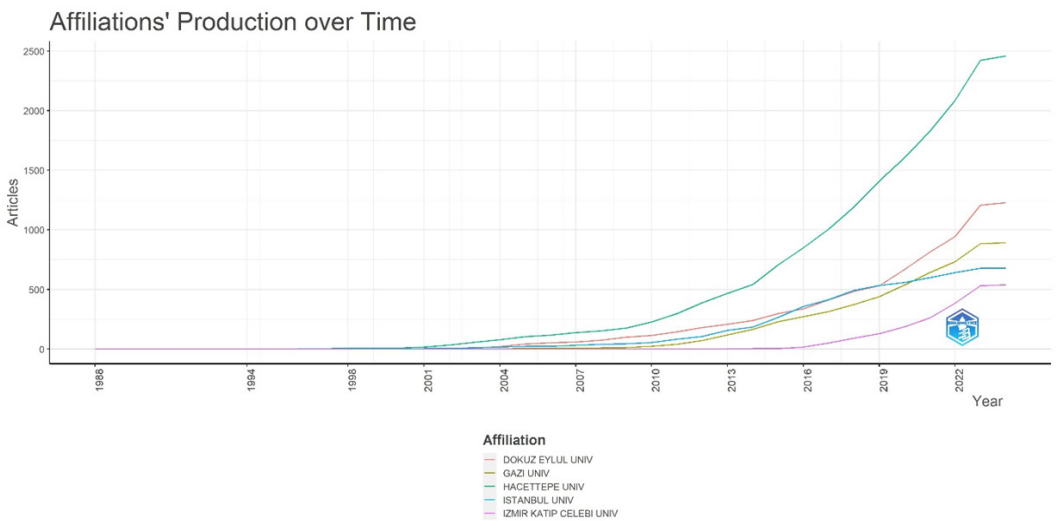

Figure 5. Affiliations' Production Over Time, Green Line: Hacettep , Blue Line: İstanbul University, Pink Line: İzmir Katip Çelebi University

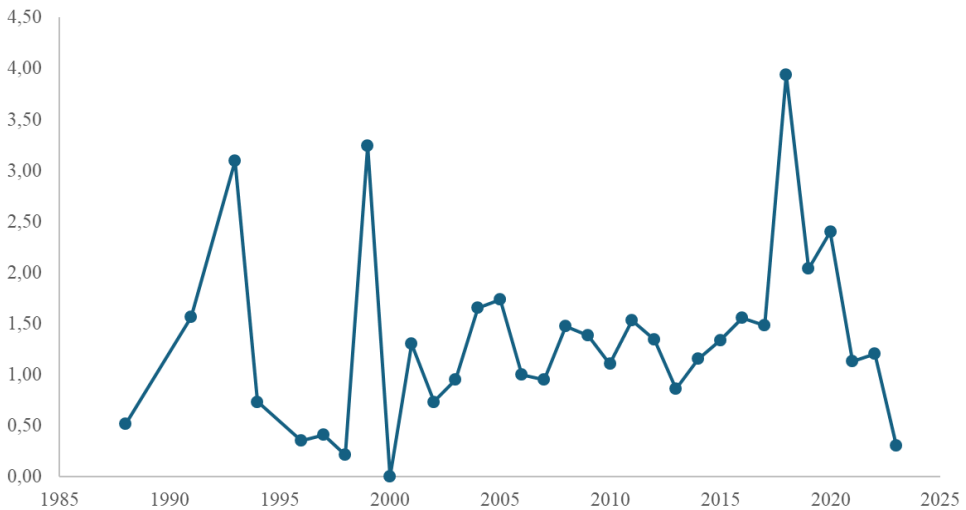

Figure 6. Average Number of Citations

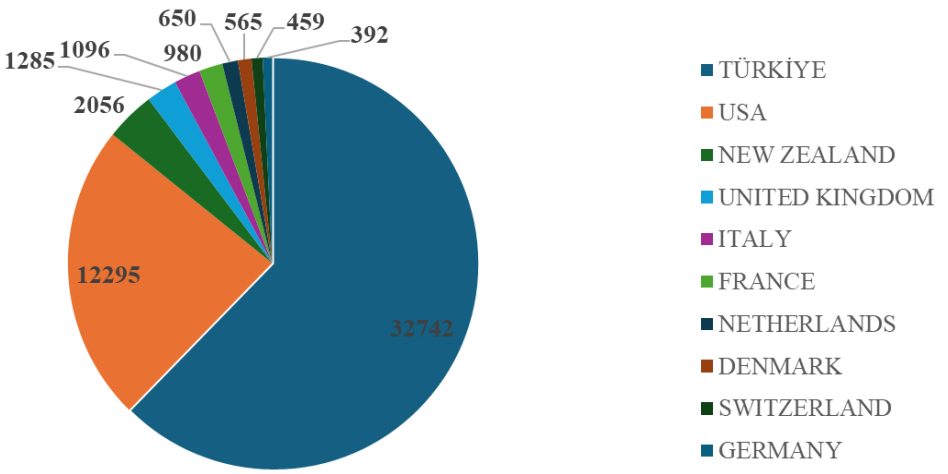

Figure 7. Most Cited Countries

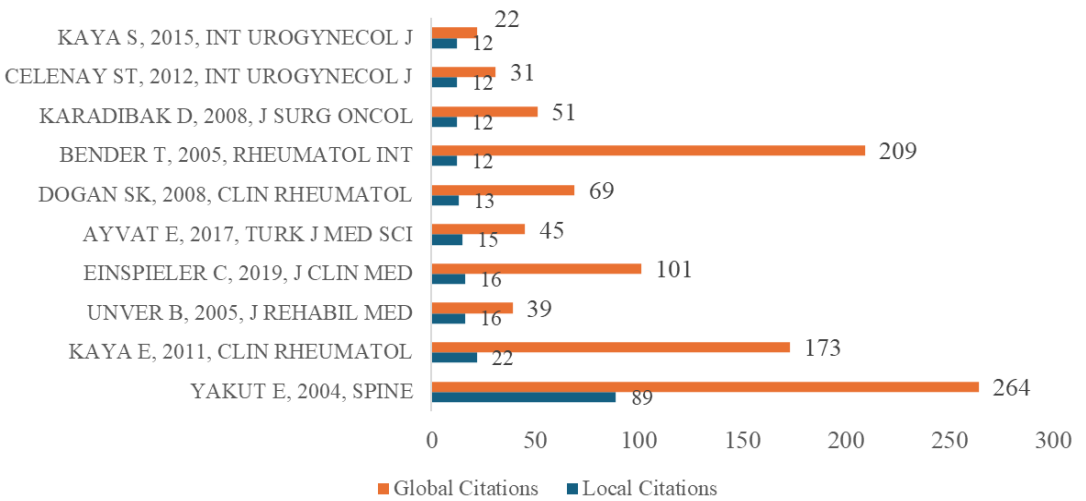

Figure 8. Most Local Cited Documents

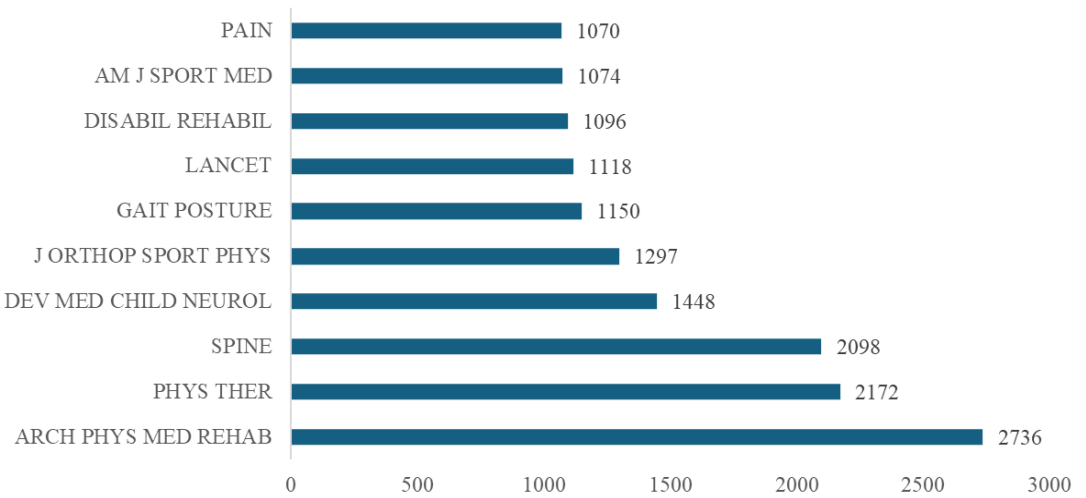

Figure 11. Most Local Cited Sources

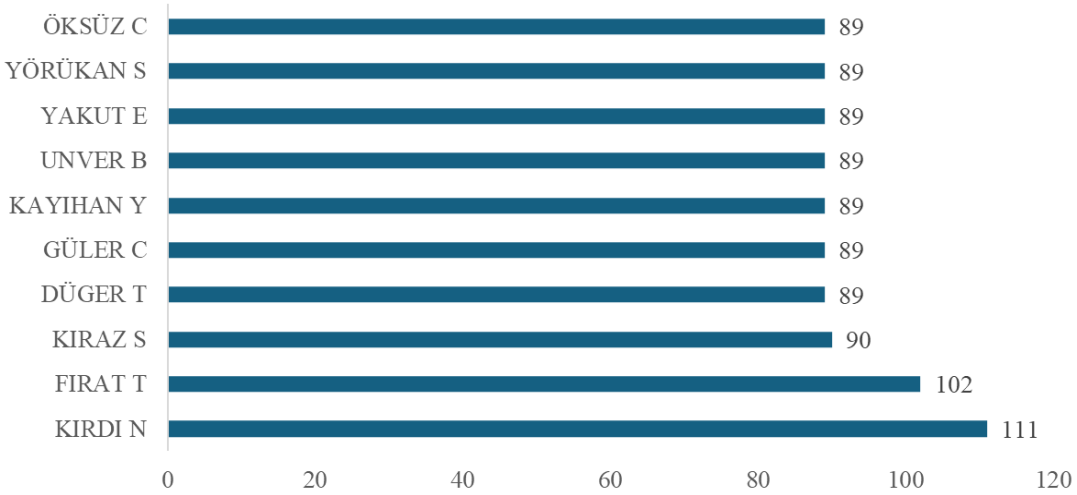

Figure 12. Most Local Cited Authors in Publications

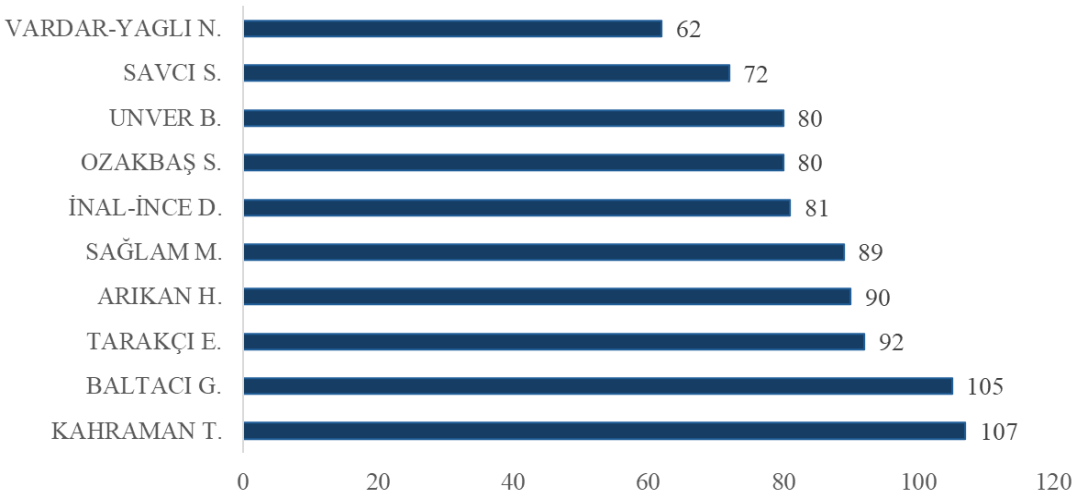

Figure 13. Most Relevant Authors

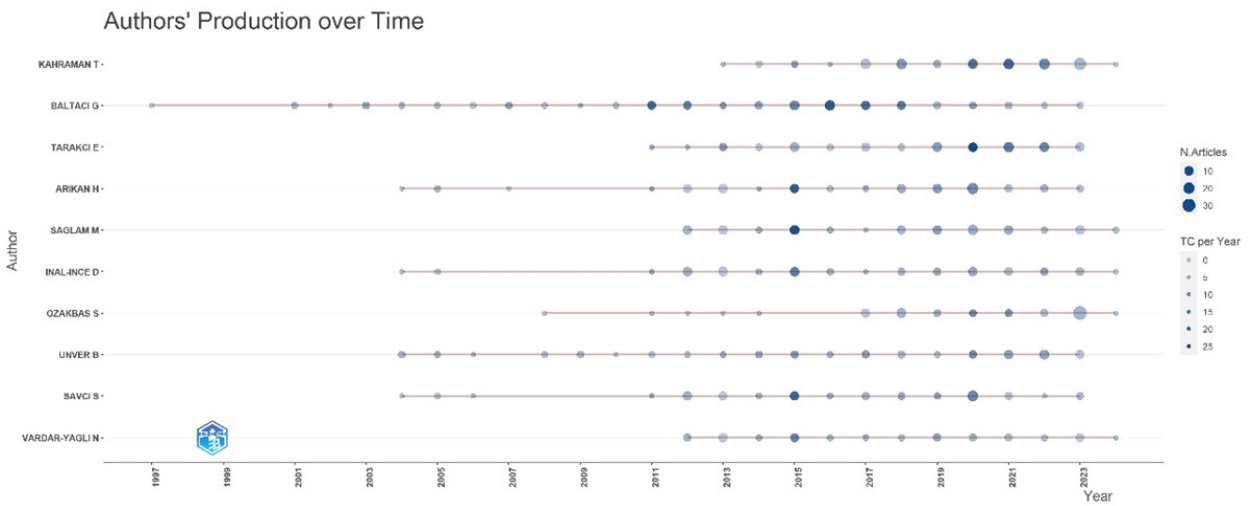

Figure 14. Authors' Production Over Time

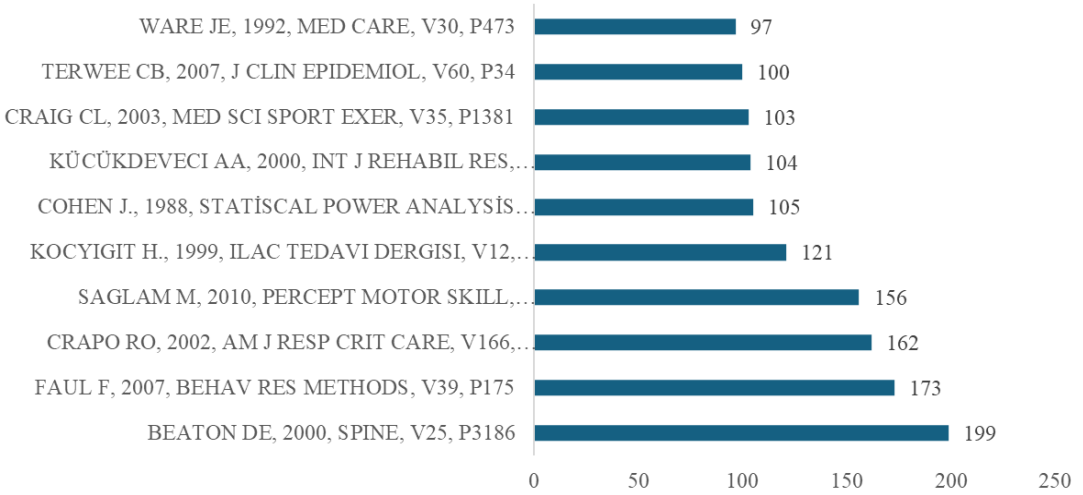

Figure 15. Most Local Cited References

Figure 17. Word Cloud (Most Frequent 50 Words)

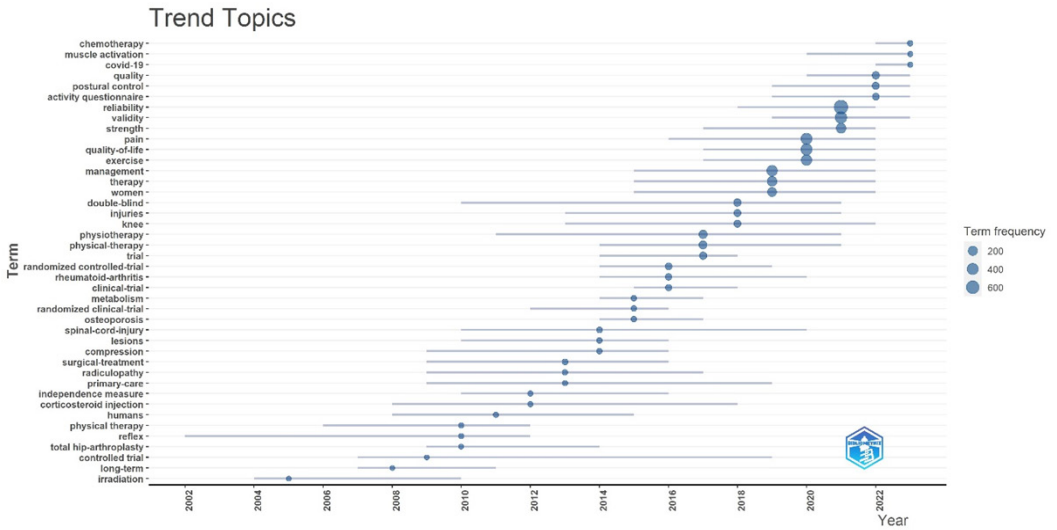

Figure 18. Trend Topics in Physiotherapy Field in Türkiye By Years

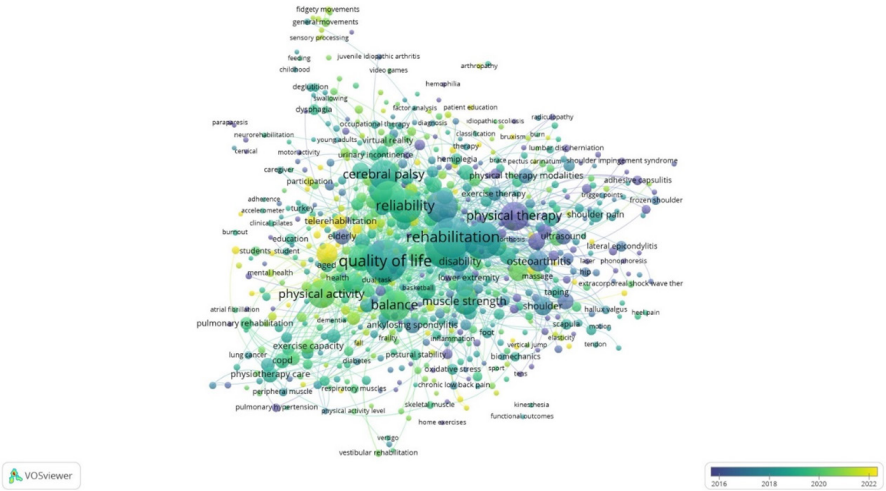

Figure 19. Usage of Keywords Over the Years

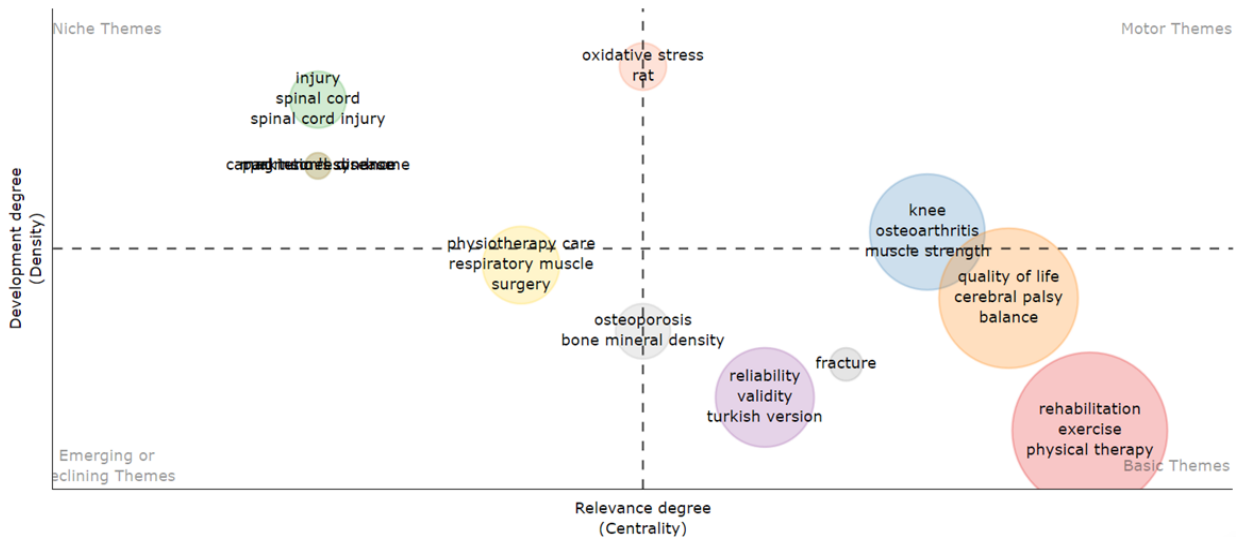

Figure 21. Thematic Evolution (Before 2016)

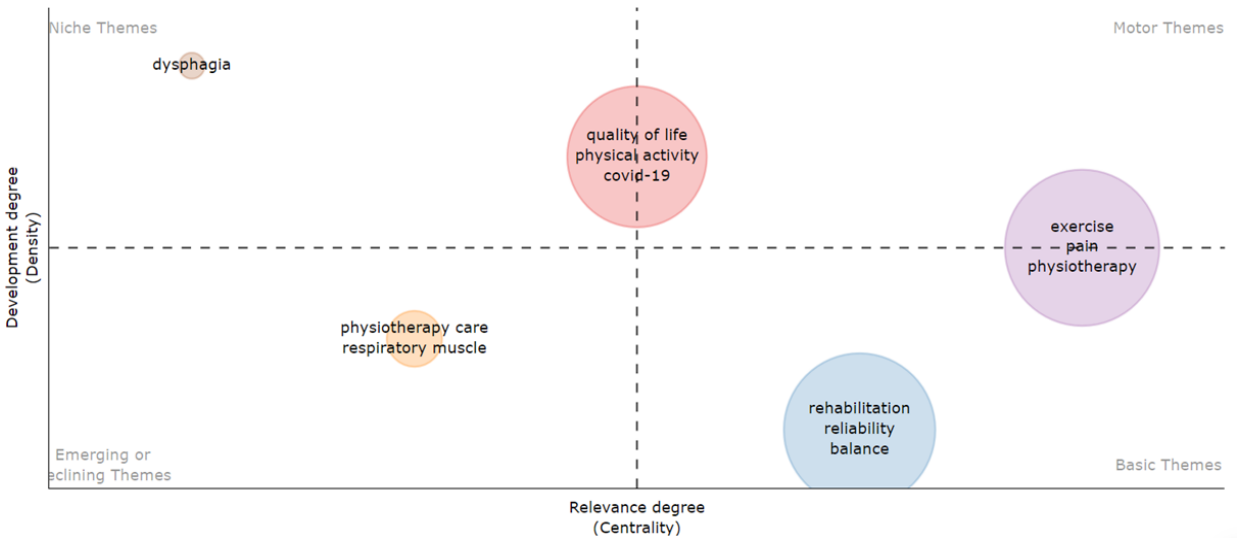

Figure 22. Thematic Evolution (After 2016)

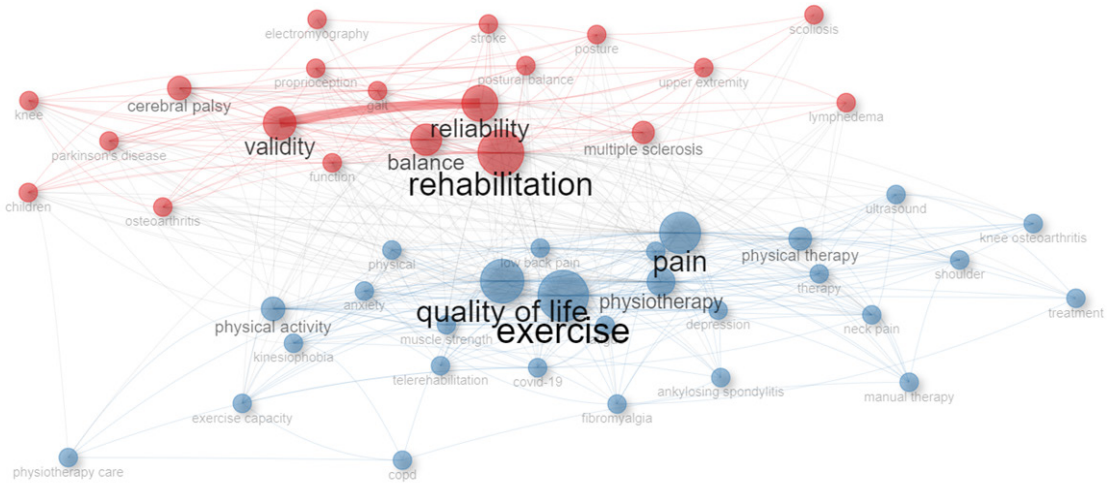

Figure 23. Co-Occurrence Network

Figure 24. Co-Authorship Relationship Between Authors

TELİF HAKKI DEVİR FORMU

Biz aşağıda imzası bulunan kişiler,.....
.....
.....
isimli makalenin tüm yayın haklarını **Türk Fizyoterapi ve Rehabilitasyon Dergisi'ne** devrediyoruz.

Aşağıda imzası olan yazarlar makaleyi dikkatlice okumuşlardır ve içeriği, dili ve biçimi konusunda fikir birliği içindedirler. Makalenin özgün olduğunu, başka bir dergide yayımlanmadığını ve başka bir dergiye yayımlanmak üzere gönderilmediğini beyan ederler.

(LÜTFEN BÜTÜN YAZARLARIN İSİMLERİNİ MAKALEDEKİ İSİM SIRALAMASINA GÖRE YAZINIZ. YAZARLARIN TAMAMININ İMZASI GEREKMEKTEDİR.)

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ÇIKAR ÇATIŞMASI FORMU:

Yazarlar bu çalışmada, herhangi bir kişi, kurum veya kuruluşla, sonuçlarında ve ifade edilen görüşlerde ön-yargılı davranmaya neden olabilecek bir mali yarar veya çıkar ilişkisinin olmadığını bildirirler. *(Not: Böyle bir yarar veya ilişki var ise, ayrıca mutlaka beyan edilmelidir.)*

(LÜTFEN BÜTÜN YAZARLARIN İSİMLERİNİ MAKALEDEKİ İSİM SIRALAMASINA GÖRE YAZINIZ. YAZARLARIN TAMAMININ İMZASI GEREKMEKTEDİR.)

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