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Sahibi *(Owner)*
Türkiye Fizyoterapistleri Derneği adına
(On Behalf of Turkish Physiotherapy Association)
Tülin DÜGER

Editör ve Yazı İşleri Müdürü
(Editor in Chief and 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

Dergimizde yayınlanan yazıların tüm telif hakları Türkiye Fizyoterapistler Derneği'ne aittir.

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 2024 yılı Nisan sayısında, koruyucu fizyoterapi yaklaşımlarından cerrahi sonrası ve palyatif dönem uygulamalarına; çocuk, gebe, hasta ve yetişkinler gibi farklı populasyonlarda ağrı, postür, denge, kas aktivasyonu, otonomik cevaplar gibi parametrelerin değerlendirilmesinden çeşitli fizyoterapi uygulamalarının bu parametreler üzerine etkinliklerine ve de Türkçe ölçek geliştirme çalışmalarına uzanan geniş bir konu yelpazesine sahip 14 araştırma makalesi ile karşınıza çıkıyoruz.

Siz okuyucularımızdan ve gelecekteki yazarlarımızdan beklentimiz, bu çalışmalardan hem klinik hem de bilimsel çalışmalarınızda yararlanmanız ve dergimizin görünürlüğünü bilimsel yayınlarınızda yapacağınız atıflarla arttırmanızdır.

Bu yıl, Türkiye dahil dünyanın 27 farklı ülkesinden üyeleri olan üyeleri olan Foundation for Global Community Health (GCH) başta olmak üzere toplam 83 üniversite ve derneğin desteklediği, Hindistan'ın Delhi NCR kentindeki Manav Rachna International Institute of Research and Studies ile BRICS Council of Exercise and Sports Science tarafından 26-29 Mart 2024 tarihleri arasında düzenlenen 3. BRICSCESS Kongresinde sunulan bildiriler de dergimizin 34. sayısına ek olarak yayımlanmıştır. Bu 146 değerli çalışmanın özetine https://dergipark.org.tr/tr/download/issue-file/77554 adresinden ulaşabilirsiniz.

Dergimizin hazırlanmasında büyük emekleri olan hakemlerimize, editörlerimize ve yayın kurulumuza huzurlarınızda teşekkürlerimi sunmak isterim. Bilime hizmeti ve fizyoterapistlik mesleğinin bilimselliğini arttırmayı ilke edinmiş olan Türk Fizyoterapi ve Rehabilitasyon Dergisinin Editör ekibi olarak 2024 yılının ilk sayısı ile sizi baş başa bırakırken, bu ayın iki güzel ve anlamlı günü olan 8 Nisan Fizyoterapistler Günü ile 23 Nisan Ulusal Egemenlik ve Çocuk Bayramı'mızı kutlar, hepinize esenlikler dileriz.

Yayın Kurulu adına,

Saygılarımla,

Prof. Dr. H Serap İNAL

Baş Editör

EDİTÖRDEN

Dear Readers,

In the April 2024 issue of the Turkish Journal of Physiotherapy and Rehabilitation, we present you with 14 research articles with a wide range of topics, ranging from preventive physiotherapy approaches to post-surgical and palliative period applications; from the evaluation pain, posture, balance, muscle activation and autonomic responses in different populations such as children, pregnant women, patients and adults, to the effectiveness of various physiotherapy applications on these parameters; and to Turkish scale development studies.

Our expectation from you, our readers, and future authors is that you benefit from these studies in both your clinical and scientific studies and increase the visibility of our journal with citations in your scientific publications.

This year, proceedings of the 3rd BRICSCESS Congress established by the Manav Rachna International Institute of Research and Studies in Delhi NCT, India, and the BRICS Council of Exercise and Sports Science between 26-29 March 2024, as a scientific meeting endorsed by a total of 83 universities and associations -especially the Foundation for Global Community Health (GCH), which has members from 27 different countries, including Turkey, were published as a supplement to the 34th issue of our journal. You can read the summaries of these valuable studies from https://dergipark.org.tr/tr/download/issue-file/77554

I would like to express my gratitude to our referees and our editorial and technical board members for their great efforts in the preparation of our journal. As the Editorial team of the Turkish Physiotherapy and Rehabilitation Journal, which has adopted the principle of serving science and increasing the scientific nature of the physiotherapist profession, we leave you with the first issue of 2024 and celebrate the two beautiful and meaningful days of this month, April 8, Physiotherapists' Day and April 23, National Sovereignty and Children's Day, and wish you all health and well-being.

On Behalf of the Editorial Board,

Kind Regards,

H. Serap İNAL, PT. Prof.

Editor-in-Chief

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Tuba Eser Karka[1], Öğr. Gör.
Taner Bayraktaroğlu[2], Prof. Dr.
Banu Ünver[3], Doç. Dr.
Gizem Alarçin[4], Öğr. Gör.

1 *Zonguldak Bülent Ecevit Üniversitesi, Ahmet Erdoğan Sağlık Hizmetleri Meslek Yüksekokulu, Podoloji, Zonguldak*
2 *Zonguldak Bülent Ecevit Üniversitesi, Tıp Fakültesi, İç Hastalıkları ABD, Zonguldak*
3 *Lokman Hekim Üniversitesi, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü, Ankara*
4 *Zonguldak Bülent Ecevit Üniversitesi, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü, Zonguldak*

Correspondence (İletişim):

Tuba Eser Karka
Zonguldak Bülent Ecevit Üniversitesi, Ahmet Erdoğan Sağlık Hizmetleri Meslek Yüksekokulu, Podoloji, Zonguldak
tuba.eser@beun.edu.tr
ORCID: 0000-0001-5570-2702

Taner Bayraktaroğlu E-mail:baytaner@yahoo.com
ORCID: 0000-0003-3159-6663

Banu Ünver E-mail: banuukarahan@yahoo.com
ORCID: 0000-0001-9758-6607

Gizem Alarçin E-mail: gzm.alarcin@gmail.com
ORCID: 0000-0002-7868-2350

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FARKLI OBEZİTE FENOTİPLERİNDE YÜRÜYÜŞE AİT ZAMAN-MESAFE PARAMETRELERİNİN İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çalışmanın amacı, android ve jinoid obezlerde yürüyüşün zaman-mesafe parametrelerinin sağlıklı bireylerden farkını araştırmaktır.

Yöntem: Çalışmaya 18-65 yaş aralığında toplam 103 olgu katılmıştır. Vücut kütle indeksi (VKİ); normal (18,50-24,99 kg/m^2) ve obez (≥30kg/m^2) olguların bel/kalça oranları (BKO) tespit edilmiştir. Obezite fenotipi bel-kalça oranına göre belirlenmiştir. Android obez 43, jinoid obez 32 ve normal kilolu 28 olgunun dinamik pedobarografik analiziyle yürüyüşün zaman mesafe parametreleri değerlendirilerek karşılaştırılmıştır.

Sonuçlar: Sallanma süresinin (sağ p=0,032, sol p=0,022), deselerasyon ivmesinin (sağ p=0,003; sol p=0,008) ve adım genişliğinin (bilateral p<0,001) üç grup arasında anlamlı olarak farklı olduğu bulunmuştur. Obez grupların ikili karşılaştırılmasında zaman-mesafe parametrelerinde anlamlı fark olmadığı görülmüştür (p>0,016). Adım genişliğinin android obezlerde normal kilolulara göre daha fazla olduğu bulunmuştur (p<0,001). Jinoid obezlerde normal kilolulara göre, deselarasyon ivmesinin (sağ p=0,001; sol p=0,003) ve sallanma süresinin (bilateral p=0,009) ise daha az olduğu ve adım genişliğinin (bilateral p=0,001) daha fazla olduğu görülmüştür. Bunun yanı sıra adım uzunluğu, kadans, akselerasyon ivmesi, duruş süresi ve çift destek süresi parametreleri açısından gruplar arasında anlamlı fark olmadığı görülmüştür (p>0,05).

Tartışma: Çalışmamız her iki obezite fenotipinde adım genişliğinin normal bireylere göre arttığını, yalnızca jinoid obezlerde sallanma süresi ve deselarasyon ivmesinin azaldığını ve total vücut yağ oranın bunu etkilediğini göstermektedir. Sonuçlarımız obezitenin yürüyüşün zaman mesafe parametrelerini etkilediğini, ancak farklı obezite fenotiplerinin bu parametreler açısından benzer özelliklere sahip olduğunu ortaya koymuştur.

Anahtar Kelimeler: Android, Jinoid, Obezite, Pedobarografi, Yürüme.

INVESTIGATION OF TEMPORAL-SPATIAL PARAMETERS OF GAIT IN DIFFERENT OBESITY PHENOTYPES

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of the study is to investigate the difference of temporal-spatial parameters of gait (TSPG) in android and gynoid obese.

Methods: A total of 103 individuals between the ages of 18-65 participated in the study. Body mass index (BMI); of normal (18.50-24.99 kg/m^2) and obesity (≥30kg/m^2), and waist/hip ratio (WHR) were evaluated. Obesity phenotype was determined according to WHR. Dynamic pedobarographic analysis of 43 android obese, 32 gynoid obese and 28 normal individuals evaluated the TSPG and compared them.

Results: Significant differences were found between the three groups in step width (bilateral p<0.001), deceleration (right p=0.003; left p=0.008) and swing time (right p=0.032, left p=0.022). When comparing the obese groups, there was no significant difference in TSPG (p>0.016). It was found that the step width was higher in android obese than in normal individuals (p<0.001). It was observed that the step width (bilaterally p=0.001) was higher, deceleration (right p=0.001; left p=0.003) and swing time (bilaterally p=0.009) were less in gynoid obese compared to the normal individuals. In addition, it was observed that step length, cadence, acceleration, stance time and double support time were not significant (p>0.05).

Conclusion: Our study shows that step width increases in both obesity phenotypes compared to normal individuals, swing time and deceleration decrease only in gynoid obese and total body fat ratio affects this. Our results revealed that obesity affects the temporal-spatial parameters of gait, but different obesity phenotypes have similar characteristics in terms of these parameters.

Keywords: Android, Gait, Gynoid, Obesity, Pedobarography.

GİRİŞ

Obezite, tüm vücut sistemleri dahil olmak üzere özellikle kas-iskelet sistemini sürekli olarak strese maruz bırakan, biyomekanik ve metabolik olarak etkileyen bir halk sağlığı sorunudur (1-14). Obezite prevalansının arttığı göz önünde bulundurulursa vücut mekaniğinin total etkilenimi göz önünde bulundurulmalıdır (1,6). Artmış vücut ağırlığı; eklemlere binen stresi arttırmakta ve yürüyüş patolojilerine yol açmaktadır (1,6,7).

Halk sağlığını tehdit eden obezite, vücut içerisinde depolanan yağ dokusunun yerleşimine göre tanımlanmaktadır. Yağ dağılımı abdominal bölgede yoğunlaştığında android obezite (1,9,15,16); gluteofemoral bölgede yoğunlaştığında ise jinoid obezite (1,15,16) olarak tanımlanmaktadır. Vücut yağ dağılım farklılıkları obezlerin vücut biyomekaniğini etkilemektedir (1,6,7,15-18).

Obezite; vucütta eklem hareketlerini kısıtlamakta, ağrı görülme sıklığını ve kırık gelişme riskini arttırmaktadır (19-26). Zayıflayan kas kuvveti ve dejeneratif kas-iskelet sistemi hastalıklarının da obezite ile doğru orantılı olduğu bilinmektedir (19-21,27,28). Vücut segmental yağ dağılımı ile biyomekanik etkilenim ilişkilendirilmektedir (1,6,7,15-18).

Obez bireylerin düşme riskinin arttığı ve kas kuvvetinin zayıfladığını bildiren çalışmalar azalmış adım uzunluğuna ve sıklığına vurgu yapmaktadır (29,30). Obezlerin normal yürüyüş paterni içersinde zaman-mesafe parametrelerini gluteofemoral bölgede aşırı yağ dokusu birikiminin etkilediğini bilinmektedir (30). Obezlerin aynı hızda yürüyen sağlıklı kilolu bireylere göre adım uzunluğu kısalarak daha yavaş yürüdüğü ve yürüyüş esnasında ise azalmış sallanma fazı ile göreceli olarak artmış duruş ve çift destek fazı olduğu saptanmaktadır (19,27). Obezlerin genellikle artmış yağ kütlesine bağlı olarak daha kısa adımlarla daha yavaş yürüdüğü ve adım genişliğinin arttığı bildirilmektedir (19-21,30).

Literatürde obez bireylerin daha yavaş yürüdüğü, daha kısa adım uzunluğuna ve daha büyük adım genişliğine sahip olduğu bilinmektedir (30-32). Bunun yanı sıra duruş fazı ve çift destek süresinin uzadığı ve sallanma fazı süresinin kısaldığı bilgisi de mevcuttur (27,30-33). Ancak yağ dağılımındaki farklılıkların yürüyüşe etkileri konusundaki bilgilerimiz sınırlıdır. Bu doğrultuda çalışmamızın amacı normal kilolu bireyler ile android obez ve jinoid obez bireylerin yürüyüşün zaman mesafe parametreleri açısından farklılıklarını araştırmaktır.

YÖNTEM

Kesitsel araştırma tasarımına sahip olan bu çalışma, Nisan- Haziran 2019 tarihleri arasında Zonguldak Bülent Ecevit Üniversitesi Obezite ve Diyabet Uygulama ve Araştırma Merkezi'nde gerçekleştirilmiştir. Zonguldak Bülent Ecevit Üniversitesi Klinik Araştırmalar Etik Kurulu'ndan 2019-04-09/01 protokol numarası ile 14/01/2019 tarihinde onay alınmıştır ve aydınlatılmış onam formunu dolduran bireyler çalışmaya dahil edilmiştir. Bireylerin yazılı ve sözlü onamı alınarak çalışmaya dahil edilmiştir. Çalışmaya 18-65 yaş arası, ayak sağlığı açısından podolojik değerlendirilmeleri yapılmış, bioimpedansmetre ile vücut yağ analizi yapılmış, pedobarografik ayak analizi yapılmış ve testleri anlayabilecek düzeyde kooperasyona sahip olan gönüllü olgular araştırmaya alınmıştır.

Vücut kütle indeksi (VKİ) ≥30 kg/m^2 ve total vücut yağ oranı yüzdesi kadınlarda ≥35 ve erkeklerde ≥25 olanlar obezite grubuna alınırken; VKİ 18,50-24,99 kg/m^2 arası olan ve vücut yağ oranı yüzdesi kadınlarda 30'un altında ve erkeklerde 20'in altında olanlar normal kilolu grubuna dahil edilmiştir.

Çalışmada; nörolojik ve inflamatuar hastalığı alt ekstemiteyi etkileyebilecek olan, denge etkilenimi olan, alt ekstemite malignitesi ve kas-iskelet cerrahisi olan, eşitsiz bacak boyu olan, amputasyonu olan, yardımcı yürüme cihazı kullanan, hamile olan, kalp pili (pace maker) olan, Tip II Diabetes Mellitus tanısını Oral Glukoz Tolerans Testi'nde alan ve görme bozukluğu ciddi düzeyde olan olgular dışlanmıştır. Değerlendirmeler sonucunda çalışmaya android obeziteli 43, jinoid obeziteli 32 ve normal kilolu 28 birey olmak üzere toplam 103 olgu alınmıştır.

Tüm olgular bel/kalça oranına (BKO) göre sınıflandırılarak BKO kadınlarda ≥0.85 erkeklerde ise ≥0,90 android obez; sırasıyla <0,85 ve <0,90 ise jinoid obez olarak tanımlanmıştır (1,30,34,35).

Çalışmada olgular demografik ve antropometrik verileri, total vücut yağ yüzdeleri ve dinamik pedo-

barografik analizi aynı fizyoterapist tarafından bir kez değerlendirilmiştir. Yaş, boy, vücut ağırlığı, VKİ, BKO ve bioimpedansmetre (TANITA BC-418, Tokyo, Japan) ile total vücut yağ yüzdesi (TVYY) verileri alınmıştır. Dinamik pedobarografik analiz ise basınçlara sensörlü platformda bilgisayara doğrudan bağlı bir ölçüm cihazı (Diagnostic Support-DIASU, Rome, Italy- Ultrasensor 3D baropodometro con 7 sensor/cm^2) ile yapılmıştır. Bu cihaz; zaman-mesafe parametreleri hakkında veri sağlamıştır. Analiz verileri; aynı taraf iki topuk arası mesafeyi adım genişliği, bir ayağın topuk vuruşu ile diğer ayağın topuk vuruşu arasındaki mesafeyi adım uzunluğu, dakikada atılan adım sayısı kadansı, yürüyüşün akselerasyon fazı ivmesini akselerasyon, yürüyüşün deselerasyon fazı ivmesini deselerasyon, sadece bir ayağın yerde olduğu zamanı duruş süresi, her iki ayağın yerde olduğu zamanı çift destek süresi ve bir ayağın yer ile temasının olmadığı zamanı sallanma süresi olarak tanımlanmıştır.

İstatistiksel Analiz

İstatistiksel analizler Windows tabanlı SPSS 22.0 paket programı (IBM SPSS Statistics for Windows, Version 19.0, IBM Corp., Armonk, NY, USA) ile yapılmış, p değeri 0,05 olarak alınmıştır.

Örneklem büyüklüğünü belirlemek için güç analizi yapılmıştır. Önceki bir çalışmaya bakılarak 0,4 standart sapma ve maksimum plantar basınçların ortalamaları arasındaki fark 0,3 alınmıştır (36). Buna göre, %80 güç ve %5 tip 1 hata payı ile her gruba en az 31 olgu alınması gerektiği hesaplanmıştır.

Değişkenlerin normal dağılıma uygunluğu görsel (histogram ve olasılık grafikleri) ve analitik yöntemler (Kolmogorov-Smirnov) kullanılarak incelenmiştir. Kategorik değişkenlerin karşılaştırılmasında Ki-kare testi kullanılmıştır. Android ve jinoid obezitesi olan gruplar ve normal kilolu bireylerden oluşan üç grubun sayısal verilerinin karşılaştırılması, değişkenler normal dağılıma uygun olmadığı için, Kruskal Wallis testi ile yapılmıştır. Anlamlı çıkan sonuçların ikili karşılaştırmaları Bonferroni düzeltmeli Mann Whitney U testi ile yapılmıştır. Hesaplanan p<0,05 değerleri istatistiksel olarak anlamlı kabul edilmiştir.

SONUÇLAR

Çalışmaya yaş aralığı 18-65 olarak dahil edilen 103 yetişkin olgu alınmıştır. Android 43 obez yaşları 22-65 aralığında (%41,75), jinoid 32 obez yaşları 18-65 aralığında (%31,07) ve normal kilolu 28 birey yaşları 21-55 aralığında (%27,18) çalışmaya dahil edilmiştir. Bu bireylerin demografik ve antropometrik parametreleri ile toplam vücut yağ yüzdelerinin karşılaştırılması Tablo 1 ve 2'de verilmiştir. Bu parametrelere göre; vücut ağırlığının ve VKİ'nin her iki obezite grubunda fazla (p<0,001), BKO'nun android obezlerin jinoid obezlere (p<0,001) ve normal kilolu (p<0,001) bireylere göre yüksek olduğu ayrıca TVYY'nin ise jinoid obezlerin android obezlere (p=0,007) ve normal kilolu (p<0,001) bireylere göre fazla olduğu bu değerin aynı zamanda android obezlerde (p<0,001) de normal kilolu bireylere göre fazla olduğu bulunmuştur.

Zaman-mesafe parametrelerinin karşılaştırılması android obez, jinoid obez ve normal kilolu bireyler arasında yapılmıştır (Tablo 3). Sallanma süresi (sağ p=0,032, sol p=0,022), deselerasyon ivmesi (sağ p=0,003; sol p=0,008) ve adım genişliği (bilateral

Tablo 1. Android, Jinoid ve Normal Kilolu Bireylerin Demografik ve Antropometrik Parametreleri ile Toplam Vücut Yağ Yüzdelerinin Karşılaştırılması

Parametreler	Android (n=43)	Jinoid (n=32)	Normal (n=28)	p
Cinsiyet (K/E)	31/12	32/0	18/10	**0,001***
Boy (cm±SD)	163,51±8,90	158,62±6,27	165,78±10,35	**0,014***
Vücut Ağırlığı (kg±SD)	102,83±17,82	102,48±15,79	62,40±11,55	**<0,001****
VKİ (kg/m^2 +SD)	38,64±7,01	40,83±6,52	22,57±2,67	**<0,001****
BKO (ort. ± SD)	0,95±0,49	0,81±0,03	0,79±0,08	**<0,001****
TVYY (ort. ±SD)	39,15±8,41	44,18±6,78	21,58±6,66	**<0,001****

*p<0,05,**p<0,001, SD: standart deviasyon, n: olgu sayısı, ort: ortalama, K: kadın cinsiyet, E: erkek cinsiyet, cm: santimetre, kg: kilogram, m: metre, VKİ: vücut kütle indeksi, BKO: bel/kalça oranı, TVYY: total vücut yağ yüzdesi.

Tablo 2. Gruplar Arası Demografik ve Antropometrik Parametreler ile Toplam Vücut Yağ Yüzdelerinin İkili Karşılaştırılması.

Parametreler	Android - Jinoid (n=75)		Normal - Android (n=71)		Normal - Jinoid (n=60)	
	Z	p	Z	p	Z	p
Boy	-2,113	0,035	-0,936	0,349	-2,663	**0,008***
Vücut Ağırlığı	-0,552	0,581	-6,883	**<0,001****	-6,379	**<0,001****
VKİ	-1,843	0,650	-7,025	**<0,001****	-6,610	**<0,001****
BKO	-7,385	**<0,001****	-6,547	**<0,001****	-1,639	0,101
TVYY	-2,694	**0,007***	-6,883	**<0,001****	-6,535	**<0,001****

*p<0,016, **p<0,001, n: olgu sayısı, VKİ: vücut kütle indeksi, BKO: bel/kalça oranı, TVYY: total vücut yağ yüzdesi.

p<0,001) parametrelerinde anlamlı fark olduğu bulunmuştur.

Her iki obezite grubunun karşılaştırılmasında zaman-mesafe parametrelerinde anlamlı kabul edilen fark olmadığı görülmüştür (p>0,016) (Tablo 4). Adım genişliğinin android obezlerde normal kilolulara göre daha fazla olduğu bulunmuştur (bilateral p<0,001) (Tablo 4). Normal kilolu bireyler ve jinoid obez bireylerin karşılaştırılmasında ise sallanma süresinin (bilateral p=0,009) ve deselarasyon ivmesinin (sağ, p=0,001; sol p=0,003) daha az olduğu, aynı zamanda adım genişliğinin (p=0.001) jinoid obezlerde bilateral daha fazla olduğu görülmüştür (Tablo 4). Bunun yanı sıra adım uzunluğu, kadans, akselerasyon ivmesi, duruş süresi ve çift destek süresi parametreleri açısından gruplar arasında anlamlı fark olmadığı görülmüştür (p>0,05).

TARTIŞMA

Android obez, jinoid obez ve normal kilolu bireylerin yürüyüşün zaman mesafe parametreleri açısından farklılıklarını araştırmak üzere planlanan çalışmamız, deselarasyon ivmesinin ve sallanma süresinin jinoid obezlerde normal kilolulara göre daha az olduğunu, adım genişliğinin android ve jinoid obezlerde normal kilolulara göre daha fazla olduğunu göstermiştir. Ayrıca, obezite fenotipleri arasında android ve jinoid obezlerde yürüyüşün zaman mesafe parametrelerinin benzer olduğu ortaya koyulmuştur. Obezitenin yürüyüşün zaman mesafe parametrelerini değiştirdiğini gösteren çalışmamız, farklı obezite fenotipleri arasında bu açıdan bir fark olmadığını ortaya koymuştur.

Perfetto ve ark. (37) ve Manigrasso ve ark. (38), vücut yağ oranının ve VKİ'nin android ve jinoid obezlerde normal bireylere göre arttığını göstermiştir. Bizim çalışmamızda da benzer şekilde her iki obezite grubunun total vücut yağ oranının ve VKİ değerlerinin normal kilolu bireylere göre fazla olduğu ortaya koyulmuştur.

DeVita ve ark. (27) obezlerin normal kilolulara göre duruş fazının süresinin görece daha uzun ve sallanma süresinin görece daha kısa olduğa bildirmiştir. Lai ve ark. (31); obez yetişkinlerin yürüyüş hızının ve adım uzunluğu azaldığını buna karşılık yürüyüşün çift destek süresinin ve duruş fazının uzadığını saptamışlardır. Sheen ve ark. (33); obez yetişkinlerin yürüşünde artmış duruş ve çift destek fazı olduğunu bunun en önemli sebebinin VKİ artışı olduğunu bildirmiştir. Çalışmamız literatüre ek olarak; yalnızca jinoid obezlerde deselarasyon ivmesinin ve sallanma süresinin normal kilolu bireylere göre azaldığını göstermiştir. Literatürde obezitenin dinamik dengede azalmaya ve enerji tüketiminde artışa neden olduğunu gösteren çalışmalar bulunmaktadır (19,30,38-40). Jinoid obezlerde deselerasyon ivmesi ve sallanma fazı süresinin azalmış olmasının dinamik dengenin azalması ve enerji tüketiminin artması ile ilişkili olabileceğini düşünmekteyiz.

Analizimiz; adım genişliğinin hem android hem de jinoid obezlerde normal bireylere göre arttığını göstermektedir. Spyropoulos ve ark. (30); obez erkeklerin normal erkeklere kıyasla daha yavaş yürüdüğünü, adım uzunluklarının daha kısa ve adım genişliklerinin ise daha büyük olduğunu saptamışlardır. Lee ve ark. (32); obez adölesanların normal kilolu adölesanlara göre daha büyük adım genişliğine sahip olduğuna değinmiştir. Bizim çalışmamız literatürden farklı olarak android ve jinoid obeziteli bireylerin her ikisinin de adım genişliğinin normal

Tablo 3. Android, Jinoid ve Normal Kilolu Bireylerin Zaman-Mesafe Parametrelerinin Karşılaştırılması.

Parametreler		Android (n=43)	Jinoid (n=32)	Normal (n=28)	p
Adım genişliği (cm)	Sağ	16,42±4,02	15,62±4,17	12,05±3,65	**<0,001****
	Sol	16,80±4,25	15,66±3,70	12,23±3,61	**<0,001****
Çift adım uzunluğu (cm)	Sağ	96,88±11,43	89,91±23,29	96,45±23,78	0,259
	Sol	98,30±10,65	93,37±18,46	102,24±11,98	0,150
Adım uzunluğu (cm)	Sağ	49,84±6,70	50,68±9,99	53,98±11,86	0,141
	Sol	48,86±4,78	50,67±11,97	53,56±11,49	0,133
Kadans (adım/dk)		20,94±3,75	21,83±4,23	21,62±2,95	0,741
Ortama çift adım süresi (sn)	Sağ	1,27±0,15	1,20±0,31	1,17±0,28	0,349
	Sol	1,28±0,16	1,23±0,18	1,25±0,12	0,804
Hız (cm/sn)	Sağ	30,28±4,85	28,10±6,33	31,09±4,71	0,076
	Sol	29,33±6,66	29,14±6,10	31,26±7,45	0,557
Akselerasyon ivmesi (cm/sn^2)	Sağ	1217,94±660,63	1047,35±741,25	1237,18±703,69	0,055
	Sol	1164,98±733,52	999,83±598,86	1488,60±1764,56	0,094
Deselerasyon ivmesi (cm/sn^2)	Sağ	-877,06±392,43	-725,02±268,15	-927,06±314,87	**0,003***
	Sol	-834,91±388,85	-735,44±262,54	-1035,38±518,68	**0,008***
Duruş zamanı (sn)	Sağ	0,83±0,23	0,89±0,36	0,79±0,17	0,316
	Sol	1,19±1,68	0,85±0,32	0,86±0,39	0,392
Duruş zamanı ÇD (sn)	Sağ	0,16±0,07	0,23±0,27	0,16±0,16	0,130
	Sol	0,28±0,31	0,21±0,20	0,21±0,26	0,244
Sallanma zamanı (sn)	Sağ	0,49±0,06	0,46±0,11	0,49±0,10	**0,032***
	Sol	0,46±0,12	0,44±0,15	0,51±0,05	**0,022***

*p<0,05, **p<0,001, SD: standart deviasyon, n: olgu sayısı, cm: santimetre, sn: saniye, cm/sn^2: santimetre/saniye kare, dk: dakika, ÇD: çift destek.

bireylere göre artmış olduğunu saptamıştır. Android ve jinoid fenotipe sahip obezlerde gluteofemoral bölgede adipoz doku yoğunluğunun fazla olabileceği ve bu yüzden adım genişliğinin iki grupta da artacağı düşünülmelidir (32,34).

Çalışmamızda; tüm alt grupların olgu sayılarının eşit olmaması, gruplar arası yaş ortalamasının farklı olması, tüm alt gruplarda kadın cinsiyette olan olguların oranının yüksek olması ve obezite fenotipinin ayrımının BKO ile yapılması limitasyondur. Ayrıca, çalışmamızda katılımcıların dominant ayakları belirlenmemiş, grupların sağ ve sol ayaklarını karşılaştırılmıştır. Bu durum da çalışmamızın bir başka limitasyonudur.

Tablo 4. Gruplar Arası Zaman-Mesafe Parametrelerinin İkili Karşılaştırılması.

Parametreler		Android - Jinoid (n=75)		Normal - Android (n=71)		Normal - Jinoid (n=60)	
		Z	p	Z	p	Z	p
Sallanma Fazı	Sağ	-1,153	0,121	-1,232	0,218	-2,631	**0,009***
	Sol	-0,705	0,481	-2,140	0,032	-2,605	**0,009***
Deselerasyon ivmesi	Sağ	-2,131	0,033	-1,745	0,081	-3,275	**0,001***
	Sol	-0,997	0,319	-2,280	0,023	-2,978	**0,003***
Adım genişliği	Sağ	-0,436	0,663	-4,119	**<0,001****	-3,282	**0,001***
	Sol	-0,901	0,368	-4,075	**<0,001****	-3,252	**0,001***

*p<0,016. **p<0,001. n: olgu sayısı.

Sonuç olarak; çalışmamız farklı obezite fenotiplerinde zaman-mesafe parametrelerinin normal kilolu bireylere göre farklı olduğunu ancak obezite fenotiplerinin kendi arasında bu açıdan fark olmadığını göstermiştir. Her iki obezite fenotipinde adım genişliğinin normal bireylere göre arttığı, yalnızca jinoid obezlerde sallanma süresi ve deselarasyon ivmesinin azaldığı ortaya koyulmuştur. Her iki obezite fenotipinde de adipoz dokunun gluteofemoral bölgede yoğunlaşmasından kaynaklı adım genişliğinin obezite gruplarında artmış olduğunu, ayrıca dinamik dengenin azalmış olmasının artmış adım genişliğine katkıda bulunmuş olabileceğini düşünmekteyiz. Dinamik denge yetersizliği ve enerji tüketimindeki artış bu bireylerde sallanma süresinin azalması ile ilişkili olabilir. Sonuçlarımız obezitenin yürüyüşün zaman mesafe parametrelerini etkilediğini, ancak bu parametrelerdeki değişikliğin vücuttaki yağ kütlesinin dağılımından değil, yağ kütlesinin artışından kaynaklanıyor olabileceğini ortaya koymuştur. Farklı obezite fenotiplerinin yürüyüşün diğer kinematik ve kinetik parametrelerine etkisini inceleyen ileri çalışmalara ihtiyaç bulunmaktadır.

Destekleyen Kuruluş: Yoktur.

Çıkar Çatışması: Herhangi bir çıkar çatışması bulunmamaktadır.

Yazar Katkıları: Fikir/Kavram- TEK, BÜ, GA, TB; Tasarım- TEK, BÜ, TB; Denetleme/Danışmanlık-BÜ, TB; Kaynaklar ve Fon Sağlama- TEK, BÜ, GA, TB; Materyaller- TEK, BÜ, GA, TB; Veri Toplama ve/veya Veri İşleme- TEK, GA; Analiz ve/veya Yorumlama- TEK, BÜ, GA, TB; Literatür Taraması- TEK, BÜ, GA, TB; Makale Yazımı- TEK, BÜ, TB; Eleştirel İnceleme- BÜ, TB.

Açıklamalar: Bu çalışma Obezite ve Diyabet Uygulama ve Araştırma Merkezi bünyesinde gerçekleştirilmiştir.

Teşekkür: Obezite ve Diyabet Uygulama ve Araştırma Merkezi çalışanlarının tamamına ve katılımcılara teşekkür ederiz.

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Rahul Krishnan KUTTY, MPT, Lecturer[1]
Ong Siew CHEE, Bsc, Research Scholar[1]
Suvinlal STALIN, MPT, Head of School of Physiotherapy[1]
Sonia Dua DEWAN, MSc Pain, Lecturer[1]
Nisha Vijayan ACHARRY, MPT, Lecturer[1]

1 *School of Physiotherapy, Faculty of Health Sciences, MAHSA University, Malaysia.*

Correspondence (İletişim):

Rahul Krishnan Kutty
Address: School of Physiotherapy, Faculty of Health Sciences, MAHSA University, Malaysia
Email address: physioraul@gmail.com
ORCID: 0000-0001-7819-6005

Ong Siew CHEE
E-mail: siewchee_ong@hotmail.com
ORCID: 0000-0001-6435-9950

Suvinlal STALIN
E-mail: suvinlal@mahsa.edu.my
ORCID: 0000-0002-9290-4327

Sonia Dua DEWAN
E-mail: sonia@mahsa.edu.my
ORCID : 0000-0002-8451-8418

Nisha Vijayan ACHARRY
E-mail: nishaacharry@gmail.com
ORCID: 0009-0008-9520-2954

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A COMPARATIVE ANALYSIS OF VARIOUS PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) TECHNIQUES ON MUSCLE FLEXIBILITY AMONG EXTENDED SITTING POSTURE INDIVIDUALS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The purpose of this research is to compare the effectiveness of different Proprioceptive Neuromuscular Facilitation (PNF) stretching techniques for hamstring muscle tightness, and to find out the best PNF technique for improving hamstring flexibility.

Methods: In this quasi-experimental designed study, 30 university students who were between 18-25 years-old, sitting >6 hours per day, and had a Active Knee Extension Test (AKET) >20º were recruited with convenience sampling and equally allocated into Group A, B and C, non-randomly. Hold-Relax (HR), Agonist Contraction (AC) and Contract-Relax-Antagonist-Contract (CRAC) stretching techniques were given respectively, 3 sessions/week, for three weeks.

Results: Paired t-test showed significant effect of each technique compared between pre-test value and post-test value of AKET measurements of Hold-relax (HR), AC and CRAC groups (p<.001). One-way ANOVA results showed significant difference between the effects of these techniques (F(2,27)=13.069, p<.001). Tukey Post-Hoc test revealed that effect was significantly greater in CRAC (-20.033°±2.666°, p<.001) and AC groups (-17.516°±1.658º, p=.047) than HR (-15.100°±2.025°). Furthermore, CRAC (p=.038) was found to have significantly greater effect than AC.

Conclusion: The PNF stretching techniques used in this study are effective in improving hamstring flexibility among university students. In addition, CRAC technique was found to be the most effective one.

Keywords: Extended Sitting Posture, Flexibility, Hamstring, Proprioceptive Neuromuscular Facilitation, Stretching

UZUN SÜRELİ OTURMA POZİSYONUNA SAHİP BİREYLERDE KAS ESNEKLİĞİ ÜZERİNE ÇEŞİTLİ PROPRİOSEPTİF NÖROMUSKÜLER FASİLİTASYON (PNF) TEKNİKLERİNİN KARŞILAŞTIRMALI ANALİZİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu araştırmanın amacı, hamstring kas gerginliği için farklı Propriyoseptif Nöromüsküler Fasilitasyon (PNF) germe tekniklerinin etkinliğini araştırmak ve hamstring esnekliğini geliştirmek için en iyi PNF tekniğini bulmaktır.

Yöntem: Bu yarı deneysel dizaynlı çalışmada 18-25 yaşında, günde >6 saat oturan ve Aktif Diz Ekstansiyon Testi (AKET) >20º olan 30 üniversite öğrencisi elverişlilik örnekleme yöntemiyle seçilmiş ve Grup A, B ve C'ye eşit olarak ayrılmıştır.. Sırasıyla tut-gevşe (HR), agonist kasılma (AC) ve kas-rahatla-antagonist kas (CRAC) germe teknikleri verilmiş ve müdahaleler deneklere haftada üç seans, üç hafta süreyle uygulanmıştır.

Sonuçlar: Paired t-testi, HR, AC ve CRAC gruplarının hepsinde ön test ve son test AKET ölçümleri arasında anlamlı farklar olduğunu gösterdi (p<.001). Tek yönlü ANOVA testi, bu tekniklerin etkinlikleri arasında anlamlı bir farklılık olduğunu (F(2,27)=13,069, p<,001); Tukey Post-Hoc testi, etkinin CRAC (-20,033°±2,666°, p<,001) ve AC gruplarında (-17,516°±1,658º, p=,047) HR'den (-15,100°±2,025°) anlamlı olarak daha yüksek olduğunu ortaya koydu.. Ayrıca, CRAC'ın (p=,038) AC'den önemli ölçüde daha fazla etkiye sahip olduğu bulundu.

Tartışma: Bu çalışmada kullanılan PNF germe teknikleri, üniversite öğrencilerinde hamstring esnekliğini geliştirmede etkili olup, en etkili olan CRAC tekniğidir.

Anahtar Kelimeler: Uzun Süreli Oturma Pozisyonu, Esneklik, Hamstring, Proprioseptif Nöromüsküler Fasilitasyon, Germe

INTRODUCTION

Sitting for long periods of time, whether at a desk, behind the vehicle, or in front of a computer screen, can be detrimental. A study of 13 studies on sitting time and activity levels discovered that people who sat for more than eight hours a day with no physical exercise had a risk of dying similar to those who smoked or were obese (1). Studies have linked prolonged sitting hours with health concerns such as heart disease, cancer, depression, diabetes and obesity. Research shows that breaking up long periods of sitting with movement at least once an hour reduces those risks, while regular exercise at other times of day does not solve the purpose (2). Nowadays, people spend most time sitting because everyday life becomes more automated and computer-based. Also, extended sitting duration is required in most occupations and educational settings (3). During Covid-19 pandemic, E-learning replacing physical classes were ordered by Malaysian Education Ministry since April 2020 (4). This causes university students to stay home every day leading to increase sitting time and even increased rate of low back pain (LBP). (5-6). In sitting, hamstring muscles are not active and kept in shortened position as knees are flexed (7). With extended sitting, these cause decline blood-muscle pumping, hamstring trigger points development and shortening adaptation results in hamstring tightness (8-9)

Hamstring muscles are a collection of long, strong muscles in which both ordinary people and athletes experience a high level of flexibility inhibition. Tightness in hamstring not only causes a decrease in movement but also poses various musculoskeletal issues. If physiologically seen, the muscle relationships of length-tension act as the shock engrossing capacity of the limb which is influenced by muscle tightness. Diminished flexibility contributes in decreased range, and prompts different musculoskeletal issues (3). Therefore, majority university students had adopted prolonged sitting habit for learning and recreations which is the main cause of hamstring tightness among them (10-11). Qamar et al. (2017) also reported that high percentage of university students (82%) with extended sitting on chair (>six hours a day) had hamstring tightness.

Extended sitting habit among university students causes high prevalence of hamstring tightness. Especially during Covid-19 pandemic, students spend more time sitting as they have E-learning classes and are restrained from going outdoors. Severe hamstring tightness can cause unnatural gait as hip, knee and ankle biomechanics were interrupted and eventually results in plantar fasciitis (12). Hamstring tightness also causes knee pathology due to the interfered distribution of load caused by muscle imbalance (9). In physical therapy and rehabilitation to deal with hamstring tightness or any muscle with tightness various physical treatment are available. One of the most popular and easy way is by stretching. Hamstring flexibility is frequently assessed using Active Knee Extension Test (AKET) in researches as it is an ideal hamstring flexibility test. Knee flexion angle >20° indicates hamstring tightness (13). For decades, static stretching technique has been utilised as the standard benchmark for various training programs, because it revealed that using static stretching technique used to increase flexibility in contrast to other methods of stretching (14).

In a recent study, they compared the effects of two active stretching techniques on hamstring flexibility in asymptomatic individuals; they used a modified hold-relax technique of proprioceptive neuromuscular facilitation (PNF) and neural mobilisation on male subjects to improve hamstring flexibility. Their findings showed that hold-relax and neural mobilisation are equally efficient in increasing hamstring flexibility (15). Static stretching (SS), dynamic stretching (DS), and Proprioceptive Neuromuscular Facilitation (PNF) are some of the prominent stretching treatments that can assist improve hamstring flexibility and prevent such issues (16).

In a similar study, conducted noted PNF to be superior to other stretching techniques (17). It is a stretching technique that promotes neuromuscular mechanism response through proprioceptors stimulations, that is used to increase muscle flexibility (18) It involves muscle active contraction while target muscle (TM) (muscle to be stretched) being held at its stretched position followed by relaxation and passive stretching (19). The three main PNF stretching techniques are Hold-Relax (HR), Ago-

nist Contraction (AC) and Contract-Relax-Antagonist-Contract (CRAC) (20). HR involves autogenic inhibition that increases muscles compliance to be lengthened following TM isometric contractions, whereas AC involves reciprocal inhibition following OM concentric contractions (21). While in CRAC, TM static contraction followed by OM concentric contraction has both reciprocal and autogenic inhibition involved (22).

Previous studies which compared effect of various PNF stretching techniques on hamstring flexibility of several populations showed different opinions on which technique is superior and beneficial for improving flexibility of a muscle. Therefore, in this study various PNF stretching techniques are compared and applied on subjects to identify the best technique. HR, AC and CRAC PNF stretching techniques to determine the most effective PNF technique for Malaysian university students with extended sitting to improve hamstring flexibility and prevent complications caused by hamstring tightness.

METHODS

A quantitative approach with a quasi-experimental design was applied in this study with a pre-test-posttest design to compare the effect of Hold-relax (HR), AC, and CRAC stretching techniques (independent variable) on hamstring flexibility (dependent variable) among university students with extended sitting posture. An informed consent was signed and the procedure were clearly explained to the participants. Before the first and after the last stretching session, AKET that contributed numerical data were performed to measure hamstring flexibility.

"Sampling" Subjects were recruited with a non-probability sampling method; convenience sampling is used. The sample size was calculated using the below formula with type-I error rate at 5% and type-II error rate at 20%: However, due to pandemics, there were limited available subjects and because of time limitations, only 30 subjects were recruited. After subjects were recruited based on selection criteria, they were allocated into one of the three groups purposively without randomization. Every group had 10 subjects. Group A received HR, Group B received AC and Group C received CRAC technique. Male and female university students aged 18-25 were included in the study. Subjects who spend more than six hours sitting a day and subjects with right hamstring positive in AKET (>20° knee extension limitation) were included in the study. Participants who don't line up with the inclusion & exclusion criteria were not selected for the study. The data were collected in a timespan from June to August 2021.

An ethical review and ethical approval are provided by the Faculty of Health Sciences Research Review Committee, MAHSA University (FRRC) by fulfilling requirements with concern to the safety and ethics of the study. (Reference Number: FOHS/PT/21/UG61). Subjects' confidentiality and anonymity were taken care of all the time. Subjects' health status and personal information were kept safe with reference to Personal Data Protection Act 2010, and will not be revealed without the agreement of the respective subject. To ensure safety during the Covid-19 pandemic, Covid-19 Standard Operating Procedures (SOP) have been strictly adhered to throughout the study.

"Procedures" To determine the effectiveness of the techniques, hamstring flexibility was assessed using AKET, the gold standard measure, with subjects actively straightening the tested knee with hip remains 90° flexed with help of stabilizing tool and the pelvic and non- tested leg also stabilized to prevent unwanted movements. A Universal Goniometer (UG) tool was used during AKET to measure knee ROM. Target samples were approached by invitation posted in university students' online common groups, whoever was interested to participate were visited at their houses nearby university as they underwent online classes. They were briefed regarding the study objectives and procedures. Screenings were done with AKET and Participant Screening Form filled up by target samples. AKET procedure was demonstrated

before performing. Subjects' hamstring flexibility was assessed with AKET before first (pre- test) and immediately after the last stretching session (post-test). Pre-test and post-test measurements (ROM) were recorded in Data Collection Table.

"Statistical Analysis" These data were analyzed using IBM Corp. Released 2017. IBM SPSS Statistics

Table 1. Paired Samples Statistics for HR, AC and CRAC Groups

Variables		Mean	N	SD	Std. Error Mean
HR	Pre-Test	137.766°	10	4.85	1.53
	Post-Test	152.866°	10	3.91	1.23
AC	Pre-Test	138.534°	10	6.27	1.98
	Post-Test	156.050°	10	5.76	1.82
CRAC	Pre-Test	135.217°	10	4.49	1.42
	Post-Test	155.250°	10	4.98	1.57

HR- Hold Relax, AC- Agonist contraction, CRAC- Contract relax – Antagonist contract

for Windows, Version 25.0. Armonk, NY: IBM Corp with confidence interval (CI) set at 95%, significance level set at p<.05. To test the hypotheses, the pre-test and post-test knee ROM of each group were analyzed with a paired t-test to determine the effectiveness of each technique based on the mean difference as the measurements were taken at two separate times which were once before and once after an intervention. One-way ANOVA was used to compare the means of three distinct groups to see if there was a statistically significant difference in the effectiveness of the strategies. The post-hoc test was run, to identify the significant group by comparing each group (23). Before running these tests, I had cleaned the data, looked for missing values, and then keyed in values to the datasheet.

RESULTS

30 subjects (18 females and 12 males) were allocated into three groups. Group A (HR) had six females(n=6) (60%) and four males(n=4) (40%) aged 22.400±2.412; Group B (AC) had seven females(n=7) (70%) and three males(n=3) (30%) aged 21.300±2.451; Group C (CRAC) had five females(n=5) (50%) and five males(n=5) (50%) aged 20.900±2.282. To test on the hypothesis on whether there is significant effect within each technique, paired t-test was performed. For HR group, mean ± SD of pre-test AKET measurement was 137.76°±4.588° and post-test AKET improved to 152.866°±3.917° (Table 1).

As presented in Table 2, the mean difference was -15.100°±2.025° between pre- test and post-test. Paired t-test result shows t(9)= -23.574, p<.001 indicating HR has statistically significant effect in improving hamstring flexibility. Thus, null hypothesis was rejected.

Paired t-test also performed to test hypothesis on the effectiveness of AC. According to Table 2, mean ± SD of pre-test AKET measurement was 138.534°±6.2773° and post-test AKET improved to 156.050°±5.7660°. Table 3 shows the mean difference was - 17.5160°±1.6587° between pre-test and post-test. Paired t-test result shows t(9)= -33.394, p<.001 indicating AC has statistically significant effect in improving hamstring flexibility, rejecting null hypothesis.

Table 2. Paired Samples Statistics for HR, AC and CRAC Groups

Variables		Mean Difference	SD	Std. Error Mean	95%CI of thedifference		t	df	Sig.(2-tailed)
				Lower	Upper				
HR	Pre-Post	-15.100°	2.02	.64	-16.54	-13.65	-23.57	9	.000
AC	Pre-Post	-17.516°	1.65	.52	-18.70	-16.32	-33.39	9	.000
CRAC	Pre-Post	-20.033°	2.66	.84	-21.94	-18.12	-23.75	9	.000

HR- Hold Relax, AC- Agonist contraction, CRAC- Contract relax – Antagonist contra (The p value (quoted under Sig. (2-tailed)) is . 000 (reported as p < . 001) statistical significance)

Table 3. Statistical analysis using One-Way ANOVA for Comparison Between HR, AC and CRAC Groups

ROM (AKET)	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	121.68	2	60.84	13.06	.000
Within Groups	125.70	27	4.656		
Total	247.39	29	-	-	-

Paired t-test was performed to test hypothesis on the effectiveness of CRAC. Table 2 shows mean ± SD of pre-test AKET measurement was 135.217°±4.4924° and post-test AKET improved to 155.250°±4.9806°. Referring Table 2, the mean difference was - 20.033°±2.666° between pre-test and post-test. Result shows t(9)= -23.753, p<.001 indicating CRAC has statistically significant effect in improving hamstring flexibility. Therefore, null hypothesis was rejected.

To test the hypothesis of whether there is significant difference between effect of these techniques, One-way ANOVA was performed. Mean differences of AKET measurements of HR, AC and CRAC groups were compared and analyzed. Result shows statistically significant difference between effectiveness of these techniques with F (2,27) = 13.069, p<.001, rejecting null hypothesis and accepting alternate hypothesis (Table3)

To identify the significant group, multiple comparisons were done with Tukey Post-Hoc test. Results revealed improvement was statistically significantly greater in CRAC (- 20.033°±2.666°, p<.001) and AC groups (-17.516°±1.658°, p=.047) compared to HR

(-15.100°±2.025°) as presented in Table 4. Additionally, there is statistically significant difference (p=.038) between effect of CRAC and AC, suggesting CRAC to be most effective.

The result of this study showed all three techniques had significant effect (p<.001) compared between mean of pre-test and post-test AKET measurement. One-Way ANOVA result showed significant difference (p<.001) between effect of these techniques. Tukey Post- Hoc Test revealed that CRAC (-20.033°±2.666°, p<.001) had most significant effect followed by AC (-17.516°±1.658°, p=.047), then HR (-15.100°±2.025°)

DISCUSSION

The study was conducted to determine and compare effectiveness of HR, AC and CRAC PNF stretching techniques on hamstring flexibility among university students with extended sitting posture. Result of current study showed all three techniques had significant effect (p<.001) compared between mean of pre-test and post-test AKET measurement. This study found significant effect of HR (p<.001), consistent with previous studies (24) found HR greatly improved hamstring flexibility of inactive female students with 20-session stretching with assessments done using AKET. Result of current study is also in accordance with study done by Rani and Mohanty (15) who found significant effect of HR on hamstring flexibility among asymptomat-

Table 4. Statistical analysis using Post-Hoc Test for Between Groups Multiple Comparison

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95%CI	
					Lower Bound	Upper Bound
HR	AC	-2.41*	.96	.047	-4.80	.023
	CRAC	-4.93*	.96	.000	-7.32	-2.54
AC	HR	2.41*	.96	.047	.023	4.80
	CRAC	-2.56*	.96	.038	-4.90	-.12
CRAC	HR	4.93*	.96	.000	2.54	7.32
	AC	2.51*	.96	.038	.12	4.90

HR- Hold Relax, AC- Agonist contraction, CRAC- Contract relax – Antagonist contract

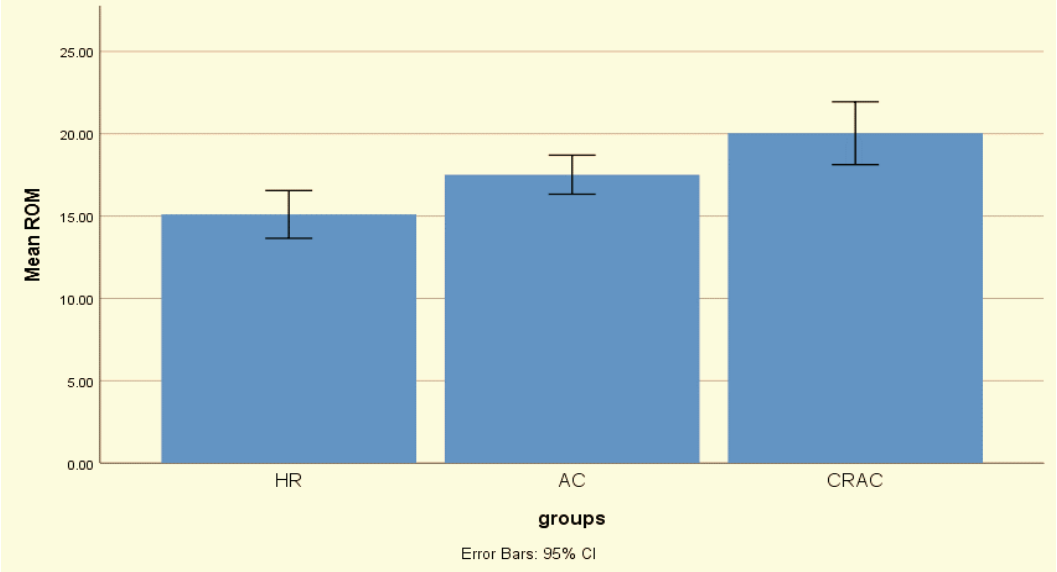

Figure 1. A Graph Representing Mean Differences of AKET of HR, AC And CRAC Groups.

ic subjects aged 20-30 in four-week intervention with 11.08°±3.08° improvement as measured with AKET. Rajendran et al. (9) also found that HR significantly improved hamstring flexibility among undergraduates with 16.46° knee ROM improvement after one-session stretching but the effect was not long-lasting. Current study provided nine stretching sessions to all participants so that accumulated effect can be more obvious to be compared and perhaps the effect can last longer to be more beneficial clinically. (25,18). Such significant effect can be attributed to autogenic inhibition mechanism as TM contracted, Ib-afferent fibers in GTO activated, which it sends signals that activate inhibitory interneurons and finally the inhibitory stimulus causes TM relaxation, decreasing resistance towards stretch. (22).

Present study also showed significant effect of AC ($p<.001$) on hamstring flexibility, consistent with study done by Naga (18) who found that AC effectively improved hamstring flexibility in subjects with hamstring tightness after one-session of AC. Result of current study also demonstrated significantly greater effect of AC ($p=.047$) than HR, consistent with study done by Ferber et al. (26) who found that AC was more effective than HR and SS in improving hamstring flexibility among active elderlies as the knee ROM improvement was 29%-34% greater. Regima et al. (21) also found that AC was significantly more effective than HR on hamstring flexibility among undergraduates. They suggested that reciprocal inhibition in AC produces greater hamstring flexibility improvement. It occurs as OM contracts which is produced by descending input and this input and Ia-afferent fiber interacted with TM Ia- inhibitory interneurons, causes TM relaxation. Moreover, OM concentric contraction moving knee joint towards maximal end range allows TM to lengthen even more as stretching force causes more neural inhibition. Also, this active stretching was suggested as another reason for AC to be more effective.

Furthermore, this study also demonstrated significant effect of CRAC ($p<.001$), in line with study done by Mani et al. (27) who found that CRAC significantly improved hamstring flexibility among male subjects with hamstring tightness after eight-week intervention with assessments done using AKET. Besides, current study found CRAC had significantly greatest effect, consistent with study conducted by Ramachandran et al. (16) and Nagarwal et al (28) who found that CRAC had significantly greater effect than HR in improving hamstring flexibility of university students after three-week stretching. Sundaram and Arun (29) also found that CRAC had most marked effect compared to HR and AC on athletes' hamstring flexibility with 25.9º±1.422° knee ROM improvement although they only looked for the immediate effect. As current study applied consistent parameter for all techniques except CRAC

involved both TM and OM contraction. Thus, the superiority could be due to both neurophysiological mechanisms involvement causing more neural inhibition and muscle relaxation than AC and HR. This is supported by Etnyre and Abraham (30) who found that HR and CRAC did suppress motor pool excitability based on Hoffman Reflex responses although excitability increased after few seconds. They found greater motor pool excitability suppression and longer lasting inhibitory effect in CRAC than HR due to the addition of reciprocal inhibition. As suggested, stretching must be done immediately after contraction when muscle relaxes (31). This were done during this study and found that CRAC had greatest effect.

Effectiveness of PNF stretching is attributed to combination of several factors (32). Beside neurophysiological mechanisms, altered stretch perception could contribute to its effectiveness. Azevedo et al (33) stated that stretching itself can alter stretch perception, the addition of contraction further alters the stretch perception. Mitchell et al. (34) found stretch tolerance in subjects who received PNF stretching was greater than those receiving SS. They supported that the contraction in PNF causes stretch perception alteration. Furthermore, PNF techniques involve stretching following contraction. As musculotendinous units have viscoelastic properties, stress relaxation will occur which is the resistance of viscous material towards stress decreased during stretching. This property causes ability to endure stretching lost over time and musculotendinous units lengthen slowly. (35)

Result of present study is inconsistent with some studies. Dafda (20) found that HR was more effective than AC as assessed with AKET. However, such difference could be due to the test procedure as subjects' pelvic and contralateral leg were not stabilized and subjects' hip flexion at 90° were manually held instead of utilizing stabilizing tool. Thus, some alteration of hip and pelvic position can be suspected. Davis et al. (36) suggested that neural tension, pelvic position and stability would affect result of an outcome measure. Oh et al. (37) found no significant difference between effect of PNF stretching techniques on university students' hamstring flexibility when assessed with SLRT. There may be more pelvic rotation in SLRT especially in persons with hamstring tightness (38). Moreover, contralateral hip flexor flexibility also affects outcome of SLRT (39). Another possibility that affects accuracy of measurement is subjects' inability to keep knee fully extended during SLRT. AKET applied in current study can overcome limitations of SLRT like pelvic movement and neurological involvements (40). Thus, such different finding of current study could be explained with the test procedure and outcome measure used.

CONCLUSION

Hamstring tightness is a common problem among university students because of extended sitting habits. It causes multiple musculoskeletal problems but is preventable with effective hamstring stretching. PNF stretching is superior to other techniques. This study compared the effectiveness of HR, AC, and CRAC PNF stretching techniques on hamstring flexibility among university students with extended sitting postures. Thirty subjects were allocated into three experimental groups. Before and after the three-week stretching, their hamstring flexibility was assessed with AKET. Based on the results, it can be concluded that all techniques are effective with CRAC to be most effective followed by AC, then HR. Thus, CRAC can bring the greatest improvement to university students' hamstring flexibility. Furthermore, the perception of pain and flexibility is also influenced by the different race of the participants (41).

This study contributes more shreds of evidence and clear confusion on which PNF technique is more effective. As this study found all techniques are effective with CRAC yielded the greatest effect, it can be applied by clinicians to effectively improve hamstring flexibility among this population who are prone to hamstring tightness. These techniques are also advisable to clinicians when treating patients with neurological disorders as these PNF techniques may help normalize tone better. The parameter applied in the current study was six seconds submaximal contraction followed by a 30-second stretch for three repetitions and found all techniques significantly improved hamstring flexibility. Thus, this parameter can serve as a reference for clinicians when applying PNF stretching.

However, this study did not manage to determine

the chronic effect after cessation of PNF stretching. Furthermore, subjects were not provided with special instruction on their activity level as they were not able to be controlled during the current pandemic.

A larger sample size is recommended to ensure the representativeness of the population and for more reliable findings. Future studies should determine and compare the sustainability of the accumulated effect of these techniques. Lastly, for more accurate ROM measurement, an electro-goniometer which is more reliable is recommended for future studies.

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Wootaek Lim, PhD[1,2]

1 *Department of PhysicalTherapy, College of Health and Welfare, Woosong University, Daejeon, Republic of Korea.*
2 *Department of Digital Bio-Health Convergence, College of Health and Welfare, Woosong University, Daejeon, Republic of Korea.*

Correspondence (İletişim):

Department of PhysicalTherapy, College of Health and Welfare, Woosong University, 171 Dongdaejeon-ro, Dong-gu, Daejeon, 34606, Republic of Korea.
E-mail: wootaeklimpt@wsu.ac.kr
ORCID: 0000-0002-5523-6294

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SEX DIFFERENCE IN ABSOLUTE AND NORMALIZED FORCE AT FOUR DIFFERENT ISOMETRIC CONTRACTION INTENSITIES: A CROSS-SECTIONAL STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: When measuring isometric contractions, providing real-time visual feedback differs from the practices in general clinical environment. In addition, even though men and women have clear physical and physiological differences, most of the existing studies analyzed absolute muscle contractions with no distinction between men and women. The aim of this study was to investigate whether there are differences in absolute and normalized hip extension forces measured without visual feedback between men and women.

Methods: Twenty-eight healthy adults participated (13 men and 15 women; age=- 22.00±11.44 years; height=165.86±18.30 cm; and weight=61.91±12.34 kg) in the study. Maximum (MVC) and submaximal voluntary contraction forces (75%, 50%, and 25% of MVC, in a random order) of hip extension were measured using a wireless strain gauge and with no visual feedback.

Results: Absolute contraction forces measured at four target intensities were significantly greater in men ($p<0.001$). Intra-trial reliability of contraction forces across 3 trials was very high in both men and women. There was a significant difference in normalized forces at 75% ($p=0.024$), 50% ($p=0.033$), and 25% ($p=0.004$) of MVC between the sexes.

Conclusion: Normalized force close to the target intensity was measured at high-intensity for men and low-intensity for women. In submaximal intensities, a decrease in normalized force smaller than the assigned target intensity occurred in both men and women as the target intensity decreased, with men showing a smaller decrease proportionally.

Key Words: Dynamometer, Hamstring Muscles, Isometric Contraction, Muscle Strength, Sex Difference

DÖRT FARKLI İZOMETRİK KASILMA YOĞUNLUĞUNDA MUTLAK VE NORMALLEŞTİRİLMİŞ KUVVETTE CİNSİYET FARKI: KESİTSEL BİR ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: İzometrik kasılmaları ölçerken gerçek zamanlı görsel geribildirim sağlamak genel klinik ortamdaki uygulamalardan farklıdır. Bununla birlikte, erkek ve kadınların belirgin fiziksel ve fizyolojik farklılıkları olmasına rağmen mevcut çalışmaların çoğunda mutlak kas kontraksiyonları cinsiyet ayrımı yapılmadan analiz edilmiştir. Bu çalışmanın amacı, erkekler ve kadınlar arasında görsel geribildirim olmaksızın ölçülen mutlak ve normalize edilmiş kalça ekstansiyon kuvvetlerinde farklılık olup olmadığını araştırmaktır.

Yöntem: Çalışmaya 28 sağlıklı yetişkin katıldı (13 erkek ve 15 kadın; yaş=22,00±11,44 yıl; boy=165,86±18,30 cm; ve vücut ağırlığı=61,91±12,34 kg). Kalça ekstansiyonunun maksimum (MVC) ve submaksimal istemli kasılma kuvvetleri ((MVC'nin %75, %50 ve %25'i, rastgele sırayla) kablosuz bir gerinim ölçer kullanılarak ve görsel geri bildirim olmaksızın ölçüldü.

Sonuçlar: Erkeklerde dört hedef yoğunlukta ölçülen mutlak kasılma kuvvetleri önemli ölçüde daha yüksekti ($p<0,001$). Tekrarlı ölçüm tutarlılığı üç deneme boyunca hem erkeklerde hem de kadınlarda çok yüksekti. MVC'nin %75'inde ($p=0,024$), %50'sinde ($p=0,033$) ve %25'inde ($p=0,004$) cinsiyetler arasında anlamlı fark vardı.

Tartışma: Hedef yoğunluğa yakın normalleştirilmiş kuvvet erkeklerde yüksek yoğunlukta, kadınlarda düşük yoğunlukta ölçüldü. Submaksimal yoğunluklarda, hedef yoğunluk azaldıkça, erkeklerde orantılı olarak daha küçük olmak üzere hem erkeklerde hem de kadınlarda belirlenmiş olan hedef yoğunluktan daha küçük bir normalleştirilmiş kuvvet azalması gözlendi.

Anahtar Kelimeler: Dinamometre, Hamstring Kasları, İzometrik Kasılma, Kas Kuvveti, Cinsiyet Farkı

INTRODUCTION

In clinical practice, maximal or submaximal voluntary isometric contractions are performed according to the patient's condition or treatment purpose (such as proprioceptive neuromuscular facilitation stretching), and muscle contraction intensity should be recorded quantitatively and/or qualitatively. In the past, manual muscle testing (MMT) was primarily utilized to measure voluntary isometric contractions. However, in MMT, subjective judgment factors of the measurer may affect the results. In addition, it has the disadvantage that quantified values in the ratio or interval scale cannot be presented, and those above normal cannot be classified in detail (1). The rating of perceived exertion (RPE), which is based on an individual's subjective judgment rather than the measurer, is also often used to measure intensity (2,3). However, it is important for physical therapists to aware that RPE can be significantly affected by psychological factors. The primary drawback of these measurement methods is the inability to quantitatively determine the absolute force produced by muscle contractions. To compensate for this, a variety of measurement equipment is currently utilized by physical therapists, ranging from specialized equipment such as isokinetic dynamometers to portable devices such as portable dynamometers and strain gauges (4,5).

However, most of the existing studies provide measured values as real-time visual feedback, helping performers to clearly distinguish each target intensity (6,7). This does not reflect the general clinical environment in which the patient cannot know his/her voluntary muscle contraction force. It is necessary to check whether the performer can produce the correct amount of muscle force based on his/her own judgment without visual feedback. In one of the previous studies, 100%, 50%, and 20% of maximum voluntary contraction (MVC) were separately performed, but the subject was a field sport athlete with better muscle performance than the general public (8). In addition, while men and women should be divided into separate groups because of their clearly different physical characteristics, analyses were conducted using overall means without grouping them by sex (9,10). A study on reliability between repetitions, not just absolute contraction force, is also needed. Research on existing reliability is mainly focused on intra-rater reliability at different time points rather than reproducibility at the same time point (11). In the case of some studies in which repetitions were performed at the same time, there is a problem in that the number of repetitions was too small to 2, or only specific trials were selectively presented in spite of performing 3 or more repetitions (12). If only the largest value is selectively presented, the variation in individual iterations is unknown, and the baseline can be set too high.

This study aimed to identify differences in absolute and normalized hip extension forces and differences in intra-trial reliability between men and women at four different target intensities (100%, 75%, 50%, and 25% of MVC).

METHODS

Study Design

This study designed as a cross sectional study. The experiment was conducted on January 29, 2020 at the College of Health and Welfare, OOOOOOO University. The study was approved by the Institutional Review Board of OOOOOOO University (Number: 1041549-191011-SB-81) and informed consent was obtained from participants prior to any study-related procedures. The research related to human use has been complied with all the relevant institutional policies and has been conducted in accordance with the tenets of the Helsinki Declaration.

Subjects

Twenty-eight healthy adults participated. Subjects were those who had no musculoskeletal or nervous system problems, and had not experienced any pain in the hip, knee, or ankle joint for the past 6 months. The sample size was calculated with the G*Power version 3.1.9.7 software (Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany), with the alpha probability of 0.05 and a power of 0.8.

Procedures

The subject lies down on the treatment table in the supine position. Pelvis and non-measured legs were fixed to the treatment table using straps. The straight leg was slowly raised by a sling (Marpe,

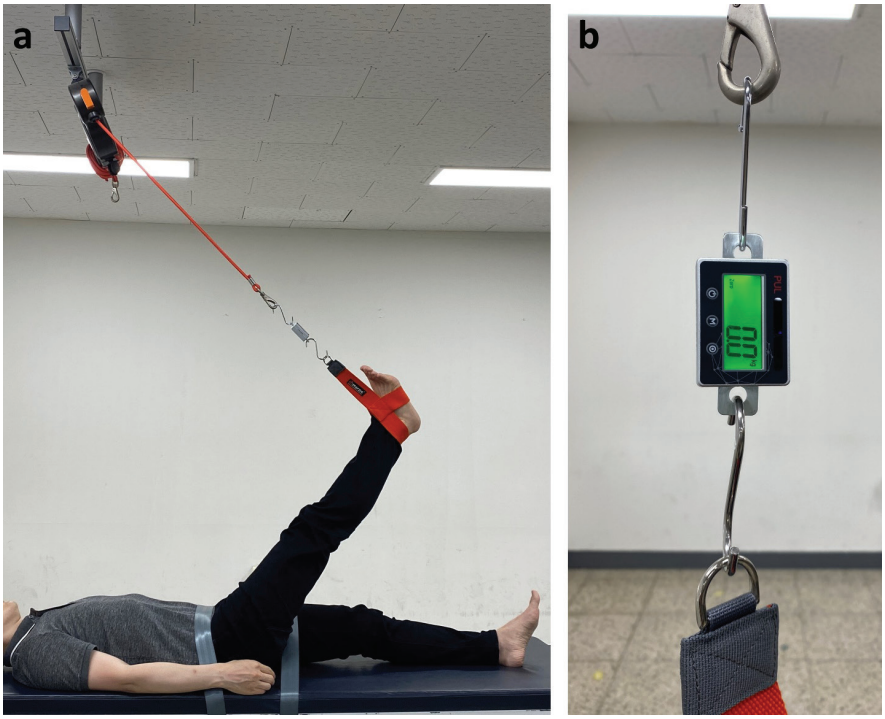

Figure 1: (a) Starting Position to Measure Absolute Force during Hip Extension (b) with Strain Gauge.

Jeonju, South Korea) until the point of discomfort. One end of the sling wire was fixed to the ceiling and the other end was connected to the ankle using an ankle strap (Figure 1a). The angle between the lower extremity and the sling wire was maintained at 90 degrees. A wireless strain gauge (Re-live, Kimhae, South Korea) was connected in the middle of the sling wire, and absolute force was recorded 4 times per second (Figure 1b) (4,7,13,14). The term "absolute force" refers to the direct force measurements obtained using the strain gauge. It provides a quantitative measurement of the actual force magnitude exerted by the subjects during hip extension. To minimize the effect of leg weight due to gravity, the strain gauge was calibrated (i.e., set to zero) before measurement. There was no visual feedback during hip extension. For MVC, total 3 trials (5 sec/trial, 10 sec rest between trials) were performed, and the middle 3 seconds were used excluding 1 second from the front and back out of 5 seconds. After MVC, 3 trials (5 sec/trial, 10 sec rest between trials) were performed in 75%, 50%, and 25% of MVC. The three submaximal target intensities were provided in random order, and sufficient rest was provided between submaximal target intensities. To calculate the normalized force, the following formula was used: Normalized Force = (Absolute Force / MVC) * 100%.

Statistical Analysis

Shapiro-Wilk was performed to test the normality of data. Based on the result of Shapiro-Wilk test, the Mann-Whitney U test was used to compare age (years) between sexes and the Independent Samples T-test was used to compare other variables such as height (cm), weight (kg), absolute contraction force (N), normalized force (%), and difference between normalized force and target intensity (Δforce, %) between sexes. Intraclass correlation coefficient (ICC; 3,1, Consistency) was used to analyze intra-trial reliability. Additionally, coefficient of variation (CV) was calculated as follows: $CV = 100 \times (2 \times (SDd / \sqrt{2})/(X1 + X2))$, where SDd is the standard deviation of the differences between two trials, and X1 and X2 represents the mean of each trial (15,16). All statistical analyses were performed using IBM SPSS 27 for Windows (IBM Corp., Armonk, NY, USA) and Microsoft Excel 2019 for Windows (Microsoft Inc., Redmond, WA, USA). The significance level was set at $p<0.05$. All values were reported as mean ± standard deviation.

Table 1. Characteristics of the Subjects.

	Men (n=13)	Women (n=15)	*p*
Age (year)	22.54±1.90	21.53±0.64	0.294
Height (cm)	173.46±3.55	159.27±4.67	< 0.001
Weight (kg)	70.69±10.42	54.30±8.18	< 0.001

Table 2. Absolute Contraction Force and Intra-trial Reliability across Three Trials at Four Different Target Intensities.

Target intensity	Sex	Absolute force	Trials	ICC	CV
100%*	Men	85.11±21.97 N	1st-2nd	0.82	11.60
			2nd-3rd	0.93	6.98
			3rd-1st	0.74	14.13
	Women	53.84±16.52 N	1st-2nd	0.80	15.37
			2nd-3rd	0.90	9.51
			3rd-1st	0.85	13.09
75%*	Men	66.19±24.66 N	1st-2nd	0.98	5.02
			2nd-3rd	0.94	9.54
			3rd-1st	0.95	8.64
	Women	32.43±14.44 N	1st-2nd	0.93	11.85
			2nd-3rd	0.98	7.02
			3rd-1st	0.91	13.37
50%*	Men	47.42±19.84 N	1st-2nd	0.93	10.90
			2nd-3rd	0.97	7.96
			3rd-1st	0.92	12.32
	Women	22.70±10.16 N	1st-2nd	0.96	9.44
			2nd-3rd	0.91	13.77
			3rd-1st	0.91	13.55
25%*	Men	28.32±13.64 N	1st-2nd	0.95	12.00
			2nd-3rd	0.94	10.85
			3rd-1st	0.85	20.00
	Women	11.38±6.21 N	1st-2nd	0.89	18.35
			2nd-3rd	0.96	11.82
			3rd-1st	0.91	16.49

*P<0.001, significantly different between men and women, ICC: intraclass correlation coefficient, CV: coefficient of variation

RESULTS

There was no significant difference in age between men and women (p=0.294) but was significant difference in height and weight (p<0.001) (Table 1). The average hip flexion angle was 63.8°. Absolute contraction forces measured at each target intensity were significantly different between men and women (Table 2). Intra-trial reliability of contraction forces across 3 trials was very high at all target intensities in both men and women. Δforces in men were 0.8±14.7%, 5.0±15.1%, and 7.9±11.5% at 75%, 50%, and 25% of MVC, respectively (Figure 2).

Δforces in women were -14.9±19.1%, -7.6±14.4%, and -4.0±8.3% at 75%, 50%, and 25% of MVC, respectively. There was significant difference in normalized forces between sexes at 75% (p=0.024),

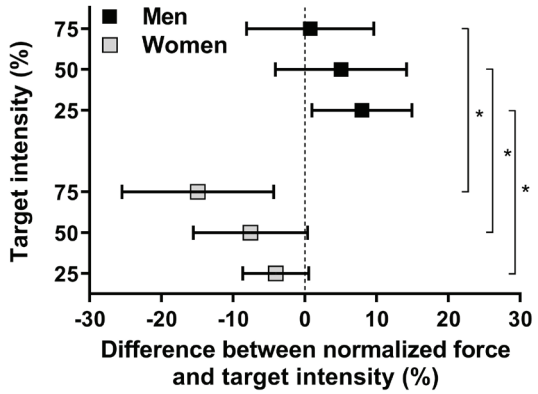

Figure 2: Difference between Normalized Force (%) and Target Intensity (% of MVC) in Men and Women.

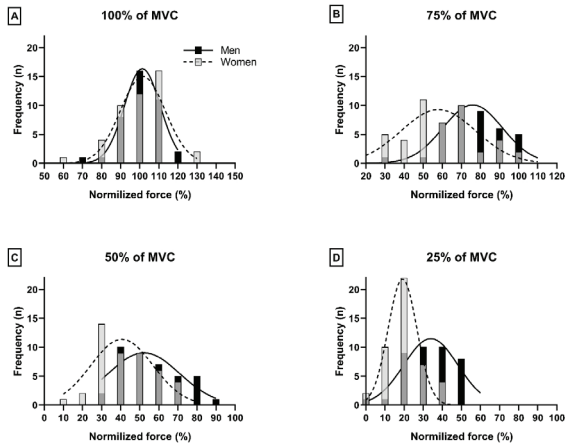

Figure 3: Frequency Distribution of Normalized Force (%) in Men and Women at Four Different Target Intensities.

50% (p=0.033), and 25% of MVC (p=0.004). The difference in frequency distribution of normalized forces between men and women was most mismatched at 25% of MVC (Figure 3).

DISCUSSION

The absolute contraction forces of men measured at four different target intensities were significantly higher than those of women. One interesting thing is that the ratio of women contraction force to men contraction force decreased gradually with decreasing target intensity. In detail, women showed 63.2%, 48.9%, 47.9%, and 40.3% of the contraction force of men at 100%, 75%, 50%, and 25% of MVC, respectively. It is already widely known that the maximal contraction force of women is lower than that of men because of the physical characteristics between men and women (17). However, if the decrease in contraction force at submaximal target intensity is relatively small compared to men, the ratio can be increased. In this study, women reduced the contraction force more than required, and it was confirmed that the ratio also decreased gradually when the target intensity decreased. Differences between men and women may be due to physical and physiological characteristics. Women has less CSA for type I, IIA, and IIB muscle fibers and less peak torque of hamstrings and quadriceps than men (18,19). The sexual dimorphism observed in muscle composition can be attributed, at least in part, to endocrine factors, specifically the influence of hormones like testosterone, which significantly modulate the process of protein synthesis (20,21). In addition to simple physical characteristics, differences between men and women are also observed in muscle extensibility and movement strategy (22,23). It is also known that women have slightly lower proprioception including threshold to detect passive motion in the lower extremities (24–26). In addition to the absolute contraction forces, the frequency distribution of normalized force also showed differences between men and women. In particular, in the case of women, a high frequency was observed in 25% of MVC. This may be because the mean of normalized force at 25% of MVC was lower than that of men, closer to 0%, which is the left end of the range, and consequently the range from min to max became narrower than that of men. In one of the existing studies, there was a difference between men and women in frequency distribution at 100% of MVC – this is probably because, in that study, the number of repetitions was 5 times and the maximum value out of the 5 trials was set to 100% of MVC, but the average of 3 times was set as 100% of MVC in the present study (27).

Since the baseline value of contraction force between men and women is significantly different, it is necessary to analyse using muscle force normalized to 100% of MVC, which is a relative value rather than an absolute value, which is contraction force (28,29). Normalized muscle forces in men were 75.8±14.6, 55.0±15.1, and 32.9±11.5 at 75%, 50%, and 25% of MVC, respectively. Normalized muscle forces in women were 60.1±19.1,

42.4±14.4, and 21.0±8.3 at 75%, 50%, and 25% of MVC, respectively. In the values of Δforce, similarities and differences between men and women are observed, respectively. First, the difference is that, in 75% of MVC, the normalized force to the assigned target intensity was the closest for men, but the most distant for women. What they have in common is that when the target intensity is lowered from 75% to 25% of MVC, Δforce increases gradually. As Δforce gradually increases as it goes to low-intensity, unlike high-intensity, it was the closest for women at 25%, while it was the most distant for men. In previous studies that did not separate men and women, under-production at high-intensity (30), and over-production at low-intensity were often observed (8). Under-production at high-intensity has been viewed as a protective mechanism to reduce the risk of injury caused by intense muscle contraction (30). If this study also performed statistical analysis with a single group without grouping by sex, contraction force would be 67.4% in 75% of MVC (under-production) and 26.5% in 25% of MVC (over-production). That is, there is a clear difference according to the characteristics of men and women, but when averaged, the difference between men and women is offset and can be interpreted differently.

If the amount of force produced by muscle during a single contraction shows a quantitative ability of muscle performance, the same amount of force produced during repeated contractions will show a qualitative ability (31). Intra-trail reliability confirmed through ICC and CV was found to be very high in both men and women except for 100% of MVC. The difference between the trials was more pronounced than the difference between men and women. When comparing the ICC measured at each target intensity, the 2-3rd trials had the highest total of 5 times, and the 3rd-1st trials had the lowest number of just once. If wishing to use consistent data in an experimental study, it is most recommended to use the average of the 2nd and 3rd trials. Unlike absolute contraction force, there was no significant difference between men and women in reproducibility. In order to maintain the same muscle contraction strength, the body provides real-time information that occurs during muscle contraction to the central nervous system via afferent pathways (32–34). This feedback mechanism is implemented by proprioceptors such as muscle spindles and golgi tendon organs (35). During muscle contraction, motor unit recruitment and rate coding are constantly adjusted to the situation, helping the muscle to maintain a constant contractile strength (36–38). Changes in neuromuscular activation can be confirmed by electromyography, and increased EMG is observed in actual sustained contraction (39). Since the feedback mechanism only provides information that occurs during movement, feedforward control of movement in the pre-contraction phase is required to generate the same amount of muscle force during repetitive contractions (40,41). Feedforward sends anticipatory input to the sensory area before movement occurs. The internal copy of the motor signal is then compared with the reafferent signals from the sensory system to determine sensory discrepancy (42). Integrated information in the feedforward and feedback mechanism will help the contraction force approximate the target intensity (43).

In a previous study conducted on lower extremity muscles, it was found that the maximum muscle contraction occurred most frequently between 3-5 repetitions (12). Three repeated measurements of each target intensity may not have been sufficient to elucidate differences between men and women. In addition, in this study, electromyography activity was not measured, so there was a limitation in interpretation.

In this study, the absolute contraction force during hip extension was measured three times at four different target intensities, and differences in absolute and normalized force with its reproducibility between sexes were confirmed. The results showed that the normalized force close to the target intensity was produced at high-intensity for men and at low-intensity for women. Also, when both men and women reduced the target intensity from high-to low-intensity, it was confirmed that the normalized force did not decrease as much as the decrease of the target intensity, and the decrease was smaller in men. In addition, there was no significant difference in reproducibility between men and women, and reliability was generally higher in 2nd-3rd trials. In clinical practice, physical therapists should

be aware that absolute and normalized muscle force may manifest in different patterns at maximal and/or submaximal intensities between sexes.

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Eylül Pınar KISA, PT, MSc[1]
Ela TARAKCI, PT, PhD, Prof[2]
Gökçe LEBLEBİCİ, PT, PhD[3]
Mehmet Akif ÇAÇAN, MD[4]
Özgür KASAPÇOPUR, MD, Prof[5]

1 *Faculty of Health Sciences, Istanbul Medipol University, Division of Ergotherapy, Istanbul, Turkey*
2 *Faculty of Health Sciences, İstanbul University Cerrahpasa, Division of Physiotherapy and Rehabilitation, İstanbul, Türkiye*
3 *Faculty of Health Sciences, İstanbul Medeniyet University, Division of Physiotherapy and Rehabilitation İstanbul, Türkiye*
4 *Faculty of Medicine, İstanbul Medipol University, Department of Orthopedics and Traumatology İstanbul, Türkiye*
5 *Faculty of Medicine, İstanbul Cerrahpaşa University, Department Of Internal Medicine, Department Of Child Health And Diseases İstanbul, Türkiye*

Correspondence (İletişim):

Eylül Pınar KISA
Faculty of Health Sciences, Istanbul Medipol University, Division of Ergotherapy, Istanbul, Turkey
eylulpinarkisa@gmail.com
ORCID:0000-0003-4707-4528

Ela TARAKÇI
E-mail:fztela@hotmail.com
ORCID:0000-0003-1330-2051

Gökçe LEBLEBİCİ
E-mail:leblebicigokce@gmail.com
ORCID: 0000-0003-1369-4016

Mehmet Akif ÇAÇAN
E-mail: mehmetakifcacan@hotmail.com
ORCID: 0000-0003-2587-6327

Özgür KASAPÇOPUR
E-mail: ozgurkasapcopur@hotmail.com
ORCID: 0000-0002-1125-7720

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IS SCOLIOSIS A COMMON DEFORMITY IN CHILDREN WITH JUVENILE IDIOPATHIC ARTHRITIS?

ORIGINAL ARTICLE

ABSTRACT

Purpose: Juvenile Idiopathic Arthritis (JIA) is the most common chronic rheumatic disease in childhood. Scoliosis can occur in children with JIA, since it mainly affects joint involvement, and contributes to the asymmetry of body and spine. This study aims to screen scoliosis in JIA, compare it with healthy controls, and evaluate the awareness among parents of children.

Methods: 218 children with JIA (163 girls, 55 boys) and 144 healthy controls (124 girls, 20 boys) aged 4-16 years were involved in this study. Angle of Trunk rotation (ATR) was measured by a scoliometer by applying a forward bending test. Children with more than 5° ATR were referred to take X-ray. To collect demographic data from parents and assess their awareness of scoliosis, forms designed for parents were used.

Results: Scoliosis was seen in 35 of the 218 (16.1%) children with JIA whose joints other than the spine were affected. 183 parents reported that they had never heard of scoliosis before the study. Scoliosis was seen in 25 children of the 183 children whose families had not heard of scoliosis before the examination. In families who had heard of scoliosis before the study, scoliosis was diagnosed in 10 of the 34 children.

Conclusion: Parents of children with JIA should pay attention not only to joints and extremities but also to the spine and asymmetries in the body. However, instead of just assessing the affected joint, professionals should evaluate children with JIA comprehensively, including the spine.

Keywords: Awareness, Deformity, Juvenile idiopathic arthritis, Scoliosis, Spine

JÜVENİL İDİYOPATİK ARTRİTLİ ÇOCUKLARDA SKOLYOZ YAYGIN BİR DEFORMİTE MİDİR?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Juvenil İdiyopatik Artrit (JİA), çocukluk çağında en sık görülen kronik romatizmal hastalıktır. JİA eklem tutulumu ile birlikte omurganın asimetrisini etkilediği için JİA'lı çocuklarda skolyoz ortaya çıkabilir. Bu çalışma, JİA'lı çocuklarda omurga taramasını ve sağlıklı kontrollerle karşılaştırmayı ve ebevynlerin bu konudaki farkındalığını değerlendirmeyi amaçlamaktadır.

Yöntem: Bu çalışmaya 4-16 yaş arası 218 JİA'lı çocuk (163 kız, 55 erkek) ve 144 sağlıklı kontrol (124 kız, 20 erkek) dahil edildi. Gövde rotasyon açısı, öne eğilme testi uygulanarak bir skolyometre ile ölçüldü. Gövde rotasyon açısı 5°'den fazla olan çocuklar ortopedist tarafından röntgene yönlendirildi. Ebeveynlerden demografik veri toplamak ve skolyoz farkındalıklarını değerlendirmek için ebeveynler için hazırlanan formlar kullanıldı. Tüm analizlerde Statistical Package for Sciences (SPSS)-24.0 programı kullanıldı. p<0,05 anlamlı olarak kabul edildi.

Bulgular: Omurga dışındaki eklemleri etkilenen JİA'lı 218 çocuğun 35'inde (%16,1) skolyoz görüldü. 183 ebeveyn çalışmadan önce skolyozu hiç duymadığını bildirdi. Taramadan önce aileleri skolyozu duymayan 183 çocuğun 25'inde skolyoz görülürken, skolyozu duyan ailelerde 34 çocuktan 10'ununa skolyoz tanısı konuldu.

Tartışma: JİA'lı çocukların ebeveynleri sadece eklem ve ekstremitelere değil, omurga ve vücuttaki asimetrilere de dikkat etmelidir. Bununla birlikte, sadece etkilenen eklemi değerlendirmek yerine, JİA'lı çocuklar omurga da dahil olmak üzere kapsamlı bir şekilde değerlendirmelidir. Bu konuda ailelelerin skolyoz hakkındaki farkındalığı büyük önem taşımaktadır.

Anahtar Kelimeler: Farkındalık, Deformite, Jüvenil idiyopatik artrit, Skolyoz, Omurga

INTRODUCTION

Juvenile idiopathic arthritis (JIA) is an umbrella term is a chronic autoimmune inflammatory disease characterized by joint inflammation and pain that lasts for at least 6 weeks and affects children who are under 16 years old. The disease involves different clinical pictures rather than being a single disease (1,2). It commonly affects large joints such as the ankle and knee and often causes structural damage (3). The altered load on the joints combined with pain, inflammation, and other mechanical factors contribute to the onset of the injury (1). This pain and inflammation cause postural and muscular imbalance with a limited range of motion in the affected joints (4,5). Persistent inflammation can lead to growth disturbances and deformities such as scoliosis (3). Scoliosis is defined as the increase in the lateral curvature of the spine by 10 degrees to the right or left in the coronal plane, as determined radiologically (6). Moreover, scoliosis is a three-dimensional complex orthopedic deformity that also involves the spine, shoulder, and pelvis (7). Although genetic factors, melatonin disorders, connective tissue disorders, skeletal muscle abnormalities, neurological mechanisms, and biomechanical factors have been attributed to the etiology of scoliosis, the true etiology of this condition is not fully understood, and it is currently defined as a multifactorial disorder (3). Studies show that it is the most common diseased spinal region affected by JIA in 77% of patients. According to the American College of Rheumatology (ACR) and recent research, the true prevalence of spine involvement may be higher due to the subclinical course of the disease (8). Since JIA, which starts with joint involvement and causes body and spine asymmetry, has become an important secondary deformity in these children (9,10). There is no study in the literature investigating the presence of scoliosis in children with JIA. Therefore, in this study, it was aimed to investigate the presence of scoliosis in children with JIA and to investigate the presence of scoliosis compared to their healthy peers.

METHODS

Study design and selection of participants: this observational study was conducted randomly in Istanbul University Cerrahpasa, Division of Pediatric Rheumatology between August-December 2022. The study was approved by the research ethics committee of Istanbul University Cerrahpasa (A-03) and conducted based on the Declaration of Helsinki. Verbal and written information about the study was provided for participants and written informed consent was obtained from all participants. This study was registered with ClinicalTrials.gov under registration number NCT04664231.

The inclusion of 218 participants was above the minimum sample size needed to ensure a power of 95% confidence level and to detect statistical significance at a two-sided significance level of 0.05 (b = 0.20) by considering the effects of size 19,4% in average between the two groups, JIA and controls, using the calculation method for the basis of descriptive studies (11).

218 children diagnosed with JIA clinically according to EULAR criteria were included in the study. 160 healthy children from pre-school to high school were screened and determined as the control group. Children with scoliosis were excluded from the study, and 144 children without spinal problems were included in the study as a healthy control group. Age-matched healthy participants were involved in the study as controls. Participants were examined by a pediatric rheumatologist and an orthopedist and met inclusion criteria.

Eligibility criteria

The following eligibility criteria applied to children with JIA: (1) had been diagnosed with JIA, (2) aged between 4 and 16 years, (3) had been diagnosed within 6 months before the study. The exclusion criteria were as follows: (1) having severe neurological, musculoskeletal, or cardiovascular disease limiting mobility, (2) having conservative scoliosis rehabilitation (exercises and braces) in the past 6 months, and (3) spinal involvement.

Assessments

Each child and parents' knowledge of scoliosis was assessed physically by a specialist physiotherapist (EPK-ET) on the spine.

Assessment of posture

Assessment of the anterior, posterior, and lateral

posture of the children was done through observation. Shoulder height, scapula height, waist-to-arm distance, hip height, genu valgum, and foot deformity were assessed anteriorly and posteriorly. The use of foot orthotics was assessed. Trunk rotation was assessed using the Adam's Bend test. Head position, thoracic kyphosis, and lumbar lordosis were assessed laterally (12).

Assessment of pain

Pain status was evaluated using a numeric rating scale (NRS). The numerical scale is commonly used from 0 to 10, with 10 indicating "the worst pain" and 0 indicating "no pain". The child is asked to draw a circle around which they feel back pain at rest (13).

Scoliometric assessment

To obtain more objective results about the spine, the angle of trunk rotation (ATR) was assessed with a scoliometer (Bunnel scoliometer) during Adam's Bend test, which the physiotherapist measures by moving the scoliometer from the beginning of the thoracic vertebra to the sacrum in the standing forward bending position. The largest ATR measured was recorded (14,15). As a result of scoliometric measurement, children with more than 5° ATR were referred to take radiographic measurement.

Radiographic imaging

The results of the radiographs were compared with the clinical assessment of the physiotherapist at the end of all measurements. Radiographic imaging assesses the degree of scoliosis by measuring the Cobb angle by the orthopedist on the image of a standing anterior-posterior radiograph and recording the largest Cobb angle. The Cobb angle is a gold standard for the evaluation of scoliosis (16,17,18).

Risser classification

To assess the maturity of ossification, the Risser classification scale has been used. The scale provides information about the development stage of the skeleton depending on the degree of ossification and fusion of the iliac crest apophysis. Since stage 0 and stage 5 may look similar, age and long bone growth plates can help distinguish these two. A stage 0 patient will still have open growth plates in most of the long bones, while a stage 5 patient will not have any open growth plates in their long bones (19).

Parent awareness assessment

To assess the awareness of the parents about scoliosis, an assessment questionnaire was prepared with questions about personal and socio-demographical information. Gender, age, weight, height, educational status of children, dominant side, affected side(s), history of the disease, duration of disease, and sports/exercise habits were questioned in detail. To inquire about parents' awareness of their children's posture, questions such as "Have you ever heard of scoliosis? Is there any person among your relatives with scoliosis? When your child bends forward, do you see any asymmetry in his/her back? Does your child have any pain in the back?" were asked from the parents.

Statistical Analysis

Statistical analysis was performed using Statistical Package for Sciences (SPSS) version 24.0 (SPSS inc., Chicago, IL, ABD). Descriptive statistics including frequency, the percentage for nominal variables, and mean and standard deviations were calculated. The Kolmogorov-Smirnov test was used to determine if the data was normally distributed. To compare quantitative variables, the student's t-test was used for normally distributed variables and the Mann-Whitney U-test was used for non-normally distributed variables. All tests were two-sided tests and p-values < 0.05 were considered to indicate statistical significance (20).

RESULTS

A total of 218 children with JIA (age range 4-16 years) whose joints were affected other than the spine was studied (Table 1). Scoliosis was found in 35 of 218 (16.1%) children with JIA. 183 parents reported that they had never heard of scoliosis before the examination. Scoliosis was diagnosed in 25 of the 183 children whose families had not heard of scoliosis before the examination. Scoliosis was diagnosed in 10 of the 34 children whose families had heard about scoliosis before the examination. Only three out of ten children with scoliosis were diagnosed with scoliosis before coming to the clinic (Figure 1).

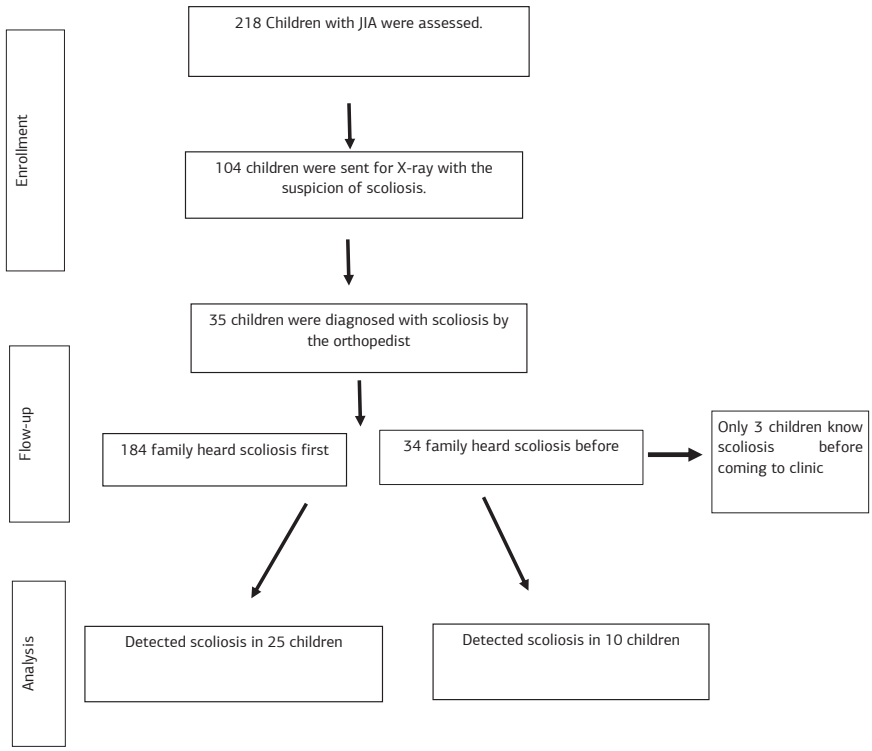

Figure I. Flow chart of parent scoliosis awareness

In the control group, a total of 160 children were examined. Scoliosis was diagnosed in 16 of the 160 (10%) children. Children with scoliosis were excluded from the study, and 144 children without spinal problems were included in the study as a healthy control group (Table 2).

188 of the children with JIA who came to the clinic had no exercise habits (p<0.001). Fifty-seven JIA children were referred to a physician for x-rays because it was suspected in the physical examination that they might have scoliosis. The clinical findings of 35 of the 57 children (%61,40) referred for radi-

Table I. Clinic Features of Children with JIA

	JIA with Scoliosis (n: 35)	JIA without Scoliosis (n: 183)
Affected joint (n, %)		
Hand-wrist	5 (10)	35 (13)
Elbow	7 (13)	41 (16)
Hip	1 (2)	2 (1)
Knee	26 (49)	110 (42)
Ankle	14 (26)	75 (28)
Type of disease		
Oligoarticular	24 (69)	115 (63)
Polyarticular RF+	1 (3)	12 (7)
Polyarticular RF-	8 (23)	51 (28)
Systemic	2 (6)	4 (2)
Disease Duration (month)		
mean±SD (min-max)	32.4±25.3 (2-120)	31.3±25.1 (1-144)
Number of affected joints		
mean±SD (min-max)	2.0±1.1 (1-6)	2.4±1.5 (1-6)

min: minimum, max: maximum, SD: standard deviation, n: number

Table II. Demographic Characteristics of JIA and Healthy Control

	JIA (n: 218)	Healthy Control (n:144)	p
Age (year) mean±SD (min-max)	10.4±2.8 (6-16)	11.1±2.9 (6-16)	0.26
Gender n (%)			
female	168(77)	124(86)	0.33
male	50 (23)	20(14)	
BMI (kg/cm2) mean±SD (min-max)	18.6±2.8 (14.3-29.5)	18.8 ±2.8 (14.2±27.6)	0.50
Children Educational status n (%)			
kindergarten	11 (5)	2 (1)	
primary school	78 (36)	42 (29)	
middle school	90 (41)	35 (25)	**<0.001**
high school	39 (18)	65 (45)	
Economic Status n (%)			
very bad	2 (1)	0 (0)	
bad	30 (14)	3 (2)	
medium	170 (78)	124 (86)	0.10
high	16 (7)	16 (11)	
very high	0 (0)	1 (1)	
Sports Habit			
Yes	31 (14)	70 (49)	**<0.001**
No	187 (86)	74 (51)	

min: minimum, max: maximum, SD: standard deviation, p<0,05, n: number, , Independent t samples t-test; significance was accepted as p<0.05.

ography were consistent with our clinical findings. The mean age of the children with JIA and scoliosis was 10.45±2.27 (p: 0.26), and the scoliometric measures were 6.57±1.89 (5-10) (p<0.001). Mean Cobb angles of 16.14±4.39 (10-27) and Risser degrees of 2.11±1.67 (0-5) were measured on the radiograph (Table 3).

DISCUSSION

Early diagnosis of scoliosis is of critical importance in terms of the negative effects it will have on the lives of adolescents and their parents in the future. This study aimed to investigate the presence of scoliosis in children with JIA and awareness of scoliosis in their parents it was found that children

Table III. Physical assessment and pain level in JIA and Healthy Control

	JIA (n: 218)	Healthy control (n:144)	p
Posture assessment (n,%)			
Shoulder asymmetry	19 (8)	49 (27)	
Scapula asymmetry	5 (2)	7 (4)	
Kyphosis	22 (9)	19 (10)	
Lomber lordosis	60 (24)	9 (5)	
Weiss asymmetry	5 (2)	7 (4)	
Genu valgum	62 (25)	11 (6)	**<0.001**[a]
Pes planus	41 (17)	21 (12)	
No deformity	31 (13)	58 (32)	
NRS mean±SD (min-max)	0.77±1.27 (0-5)	0.67±1.37 (0-6)	0.47
Foot deformity (n, %)			
Have deformity	173 (79)	25 (17)	**<0.001**[b]
Have not deformity	147 (21)	119 (83)	
Using sole (n, %)			
Using	71 (32)	0 (0)	**<0.001**[b]
Not using	125 (68)	144 (100)	
Degree of Scoliometer ( ) mean±SD (min-max)	2.3±2.5 (0-10)	0.9±1.5 (0-6)	**<0.001**[b]

min: minimum, max: maximum, SD: standard deviation, [a] Chi-square test; significance was accepted as p<0.05., [b] Independent t samples t-test; significance was accepted as p<0.05.

with JIA without spinal involvement have a high risk of scoliosis and the families of children with JIA who had scoliosis were not aware of it. Therefore, this study focuses on the importance of spinal screening in children with JIA.

Scoliosis progresses slowly from the beginning. Thus, observation and care are very important to prevent deformities from developing during the acceleration phase. Therefore, school screening for scoliosis during the growth phase is recommended, especially at the age of bone development, which is 13 years for males and 11 years for females (10). Although the American Academy of Orthopedic Surgeons (AAOS), the Scoliosis Research Society (SRS), the North American Pediatric Orthopedic Society and the American Academy of Pediatrics, early detection is low cost and carries a minimal risk of exposure to radiation, supports routine screening, arguing that conservative treatment will increase the chance of effective treatment (21). Children should be screened for scoliosis at any age group, especially in the 10-15 years age group where the growth is the most rapid. Scoliosis screening is recommended by the Scoliosis Research Association (22,23) twice a year for girls aged 10 and 12 years and once a year for boys aged 13 or 14 years.

Scoliosis screening for healthy children is performed regularly in many countries. There is no national scoliosis screening program in our country yet. It is known that regional scoliosis screenings have been carried out from time to time by some university hospitals and with the efforts of district municipalities to reveal scientific data. The current level of evidence in the literature that routine scoliosis screening is necessary is low to moderate. Although various procedures have been developed for the treatment of scoliosis, the most effective treatment still relies on early diagnosis. The lack of routine scoliosis screening program in many regions may delay early diagnosis. In our study, we revealed that the awareness of families about scoliosis is low. Therefore, it is very important to increase the awareness of scoliosis in the society (24,25). However, unfortunately, an additional assessment form for children with rheumatoid arthritis is not available. The fact that we found scoliosis in 16 of the elementary, middle, and high school children whom we considered to be in a healthy control group during our study may indicate that we should increase scoliosis screening in school-aged children. Although scoliosis scans will continue to be performed in schools as a part of the studies, we believe that the comprehensive inclusion of scoliosis scans in routine screening in JIA clinics will be effective in controlling the disease and preventing its progression.

Scoliosis screening will both ensure early diagnosis of scoliosis in children and raise the awareness of this issue among families (26). One of the strengths of our study is that it fills a gap in the literature by looking at the knowledge of scoliosis among parents of children with JIA. This knowledge is crucial for informing families about this condition (27).

Scoliosis occurs in 2-4% of children aged 10-16 years (28). As a result of our study, although the sample size was not large enough to give a prevalence, previously unreported scoliosis was detected in 16 (10%) of the 160 healthy children and 35 (16%) of the 218 children with JIA. These rates suggest that scoliosis rates seen in children with JIA is higher than healthy children. This highlights the importance of examining the spine as well as the affected joints in children who come to the rheumatology clinics even if they have other joint involvement.

Families try to control the symptoms in the affected joint as soon as possible because they are afraid of seeing edema, discomfort, and joint restriction in the affected joints due to the characteristics of the disease. Meanwhile, it neglects other parts of the body. This information was confirmed in our study.

In a study by Weiss et al (29), it is reported that children avoid putting weight on the joints or using the extremities mainly because of pain. The pain is said to cause kinesiophobia in children (30). In our clinical experience, most children with JIA have kinesiophobia with weight transfer due to pain experiments. This causes children to shift their weight to the opposite end of the affected joint or develop a compensatory mechanism in the body to protect the painful extremity. This situation leads to scoliosis as it affects the overall biomechanical alignment. The reason for scoliosis in children with oligoarticular JIA may be the constant shift of the

body's center of gravity to one side due to unilateral joint involvement.

Pain is not expected in children with scoliosis at an early age (31,32). Lonner et al (33) compared two groups of adolescents, including 894 with adolescent idiopathic scoliosis (AIS) and 31 healthy controls. Pain scores on the specific subdomain of the SRS-22 (Scoliosis Research Society Outcomes Questionnaire-22) questionnaire were similar in the scoliosis group and the control groups. Another study that examined a random sample of 310 children concluded that the prevalence of back pain was "moderately high," but the reported data on pain did not appear to be very homogeneous. Severe pain was documented in only 1% of the charts (31). Our study did not aim to ask about rheumatic pain but about the presence of back or low back pain to determine if it was scoliosis-related pain. The results of the study showed similarities in that the level of pain was found to be non-significant in both children with JIA and healthy children.

Norgaad et al (34) examined activity habits in JIA compared to gender- and age-matched healthy controls (age range 10-16 years). They found that children with JIA participated less in sports activities and had more difficulties in physical education than their healthy peers, despite having near-normal functional abilities. However, children with JIA did not differ significantly from their healthy peers. In our study, it was found that both groups had no sports habits. We believe that this is due to the discomfort that children with JIA.

Certain limitations of these previous studies are relevant to the discussion: (i) not all children were sent for X-ray, (ii) there is a need for further studies with larger samples to determine the prevalence, (iii) the study was conducted in a single center and (iv) parent awareness assessment questionnaire is not valid because it was created by us.

In conclusion, these findings suggest that therapists working with JIA should focus on all joints holistically, rather than a single joint. Exercise and assessment programs should involve the whole body, bearing in mind that all biomechanics may be affected rather than just exercising for the affected joint(s). Considering the frequency of scoliosis in children who do not have any disease, it is of great importance to perform routine screening. Families with chronically ill children and families who think they have healthy children should be informed and educated about scoliosis in terms of early diagnosis. We believe that spine scanning in children with JIA should become standard practice in rheumatology clinics and social awareness should be created through the coordinated efforts of families, physiotherapists, and health professionals.

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Hayriye Tomaç PT, MSc[1]
Emine Handan Tüzün PT, PhD, Prof[1]
Levent Eker MD, Assist Prof[1]

THE EFFECTS OF VIRTUAL REALITY TRAINING ON BALANCE AND SPEED-AGILITY IN OBESE CHILDREN: A RANDOMIZED CONTROLLED TRIAL

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of the study was to examine the effects of virtual reality training on balance and speed-agility in obese children.

Methods: The study included 34 obese children at the ages of 9-11. Participants were divided into training and control groups using the simple randomization method. The participants in the intervention group (n=17) were taken into virtual reality training for 6 weeks. No treatment was applied on the control group (n=17). Balance was assessed by the Flamingo and Y balance tests. Speed-agility was assessed by the Bruininks-Oseretsky Test of Motor Proficiency-Brief Form-speed-agility sub-test. The physical activity enjoyment levels of the children in intervention group were assessed by the Short Form-Physical Activity Enjoyment Scale.

Results: Before the study, the groups were similar in terms of the investigated variables (p>0.05). Speed-agility scores and Y balance test anterior, posterior-lateral and mixed reaching distances of the children in intervention group significantly increased after the training in comparison to their pre-training results (p<0.05). While the Flamingo balance test results significantly increased from pre-training to post-training (p=0.001), considering along with the 95% CI, the increase was found to be insignificant (-0.42—7.42). In intervention group, except for the Y balance test anterior and posterior-medial reaching distances, static and dynamic balance and speed-agility clinical effects were large (r≥0.5). All participants in intervention group stated that they enjoyed virtual reality training to the highest degree (95% CI:25.0 —25.0).

Conclusion: Virtual reality training in obese children is effective in improvement of balance and speed-agility, and it is an enjoyable option of physical activity. The large randomized controlled studies with long-term trainings and follow-up are recommended.

Keywords: Postural Balance, Child, Obesity, Therapeutics, Virtual Reality

SANAL GERÇEKLİK EĞİTİMİNİN OBEZ ÇOCUKLARDA DENGE VE HIZ-ÇEVİKLİK ÜZERİNDEKİ ETKİLERİ: RANDOMİZE KONTROLLÜ ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çalışmanın amacı, obez çocuklarda sanal gerçeklik eğitiminin denge ve hız-çeviklik üzerindeki etkilerini incelemektir.

Yöntemler: Çalışmaya 9-11 yaşlarında 34 obez çocuk dahil edildi. Katılımcılar basit randomizasyon yöntemi ile eğitim ve kontrol grubuna ayrıldı. Eğitim grubundaki katılımcılar (n=17) 6 hafta boyunca sanal gerçeklik eğitimine alındı. Kontrol grubuna (n=17) herhangi bir tedavi uygulanmadı. Denge, Flamingo ve Y denge testleri ile değerlendirildi. Hız-çeviklik Bruininks-Oseretsky Motor Yeterlilik Testi-Kısa Form-hız-çeviklik alt testi ile değerlendirildi. Eğitim grubundaki çocukların fiziksel aktiviteden keyif alma düzeyleri Kısa Form-Fiziksel Aktiviteden Keyif Alma Ölçeği ile değerlendirildi.

Bulgular: Çalışma öncesinde, gruplar incelenen değişkenler açısından benzerdi (p>0,05). Eğitim grubundaki çocukların sürat-çeviklik skorları ve Y denge testi ön, arka-yan ve karışık uzanma mesafeleri eğitim sonrasında eğitim öncesine göre anlamlı olarak arttı (p<0,05). Flamingo denge testi sonuçları eğitim öncesinden eğitim sonrasına anlamlı olarak artarken (p=0,001), %95 GA ile birlikte değerlendirildiğinde artışın önemsiz olduğu görüldü (-0,42-7,42). Eğitim grubunda, Y denge testi anterior ve posterior-medial uzanma mesafeleri dışında, statik ve dinamik denge ve hız-çeviklik klinik etkileri büyüktü (r≥0,5). Eğitim grubundaki tüm katılımcılar sanal gerçeklik eğitiminden en yüksek derecede keyif aldıklarını belirtti. (%95 CI:25,0 -25,0).

Sonuç: Obez çocuklarda sanal gerçeklik eğitimi denge ve hız-çeviklik gelişiminde etkilidir ve fiziksel aktivite için eğlenceli bir seçenektir. Uzun süreli eğitim ve takip içeren geniş randomize kontrollü çalışmalar önerilmektedir.

Anahtar Kelimeler: Postüral Denge, Çocuk, Obezite, Terapötik, Sanal Gerçeklik

1 *Eastern Mediterranean University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Famagusta, Northern Cyprus.*

Correspondence (İletişim):

Hayriye Tomaç PT, MSc
Eastern Mediterranean University,
Faculty of Health Sciences,
Department of Physiotherapy and Rehabilitation,
Famagusta, Northern Cyprus, 10 Mersin, TURKEY.
E-mail: hayriye.tomac123@hotmail.com
ORCID ID: 0000-0002-8245-9995

Emine Handan TÜZÜN
ORCID ID: 0000-0001-6989-6675
E-mail: handan.tuzun@emu.edu.tr

Levent EKER
ORCID ID: 0000-0001-7301-4073
E-mail: ekerlevent955@gmail.com

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INTRODUCTION

The World Health Organization (WHO) defines obesity as "abnormal or excessive accumulation of fat in the body to an extent that would detriment health" (1). The incidence of childhood obesity is increasing in the entire world. According to the data of WHO, 15% of school age children in the region of Europe in 2010 were obese, while 40% were overweight (2). The prevalence of obesity and overweight in children and adolescents significantly increased in the period of 2000-2010 among school-age children in Northern Cyprus (3). It is known that obese children have poorer postural performance and lower motor skills in comparison to non-obese children. The changes in the body morphology of overweight individuals negatively affect postural stability by changing the center of mass of the body (4). With increased body weight, there are biomechanical restrictions in standing up straight, and in connection to this, there are significant degradations in static and especially dynamic balance. Falls due to weak balance control and related injuries are also seen frequently (5,6). Orthopedic problems and postural changes lead to a decrease in the mobility of the child and their ability to participate in physical activities (4-6). Poor physical capacity and low performance levels make physical activity less attractive for obese individuals (7). To participate in exercise and sports, the ability to control static and dynamic balance is important and necessary. Participation in physical activity plays a significant role in prevention and treatment of obesity in children (8).

The fight against childhood obesity usually fails due to reasons such as that obesity-related problems in childhood cannot be sufficiently explained to children, they are easily bored of the methods that are applied, parents are not adequately equipped regarding the severity of the problem and cultural effects (9,10). For this reason, in order to provide children with habits of physical activity and exercise through games and make these into a lifestyle, exergaming intervention are utilized. Exergaming Intervention (EI) is a three-dimensional simulation model that is created by computers and provides the sense of reality by allowing opportunities of interaction with a dynamic environment for its users. It was reported that EI speeds up motor learning, allows the person to transition from a passive state to an active state, contributes to solution of balance problems and is a source of fun and motivation for children (11). Although Exergaming Intervention (EI) has been used as a physical activity modality among various populations, the evidence regarding its effectiveness on balance and speed-agility outcomes in obese children remains unclear (12). The purpose of this study is to investigate the effects of EI on balance and speed-agility in obese children.

METHODS

Participants

The randomized controlled studied was carried out on children at the ages of 9-11 who had higher than the 95th percentile of body mass index (BMI) based on their age and sex who were enrolled at a primary education school in the Famagusta district of Northern Cyprus between March 2017 and June 2017 (13). The sample size was calculated based on the data of the study by Sheehan and Katz which investigated the effects of a 6-week exercise program on the balance of 4th-grade primary school students by using an iDance™ device (14). In the study by Sheehan and Katz, based on the postural stability pretest-posttest scores for the group where exergaming was applied, the effect size was calculated as d=1.53. In our study, under the assumptions that two-tailed Mann-Whitney U test would be used, α=0.05, d=1.53 and β=0.05, and the cases would be equally distributed between the groups, the initial sample size was calculated as 26. Considering that some participants could drop out of the study, this sample size was increased by 30%, and the final sample size was determined as 34, so that there would be 17 participants in each group. The participants who were included in the study were randomly divided into two groups by simple randomization method using the "Random Allocation Software". EI was applied with the children who were included in the first group (intervention group=IG). The second group of children constituted the control group (CG), and no intervention was applied. Children whose cognitive skills were on a level where they could understand the instructions who had not participated in a partic-

ular sports program for at least the last 3 months were included in the study.

Children who had previously received a psychiatric diagnosis, had musculoskeletal disorders, neurological, orthopedic problems, heart and respiration problems, vestibular disorders, sight, hearing, speaking, eating and thyroid function disorders were excluded.

This study was approved by the Health Ethics Committee of Eastern Mediterranean University (decision dated 06.03.2017 and numbered 2017/39-13). The families of the children who participated in the study were informed in written form, and they signed voluntary consent forms.

Measurements

Demographic characteristics

The participants' age, gender, height, body weight, BMI and dominant side were recorded. Body weight was recorded by an analysis monitor (Tanita SC-330) (15). Height was measured with bare feet on the Frankfurt plane with a non-flexible measurement tape fixed on the wall (16). The lower extremity dominant side was determined as the extremity with which a ball was kicked. For the participants in both groups, their average daily sleeping duration, their daily duration spent in front of the television or computer and weekly days spent in front of the television or computer were recorded.

Static balance

The static balances of the participants were evaluated with the Flamingo balance test. For the test, a wooden beam with the length of 50 cm and height of 4 cm and a stopwatch were used. The children were asked to remove their shoes and stand up with one foot as flamingos do for 1 minute in the middle of the long line. They were asked to flex their knee on the other side while one side was on the floor. The knee that was in flexion was held with the hand on the same side. A trial was made before the test so that the children would get used to the test. The test that started with the instruction to start was ended by stopping the stopwatch when the balance was broken, or in other words, when the other foot touched the floor. The test protocol was repeated after each contact of the other foot with the floor and continued until the end of the 1 minute. The child received a score based on how many trials they made within 1 minute. If the balance was broken more than 15 times within 30 seconds or the child fell, the test was stopped, and the child was given "0" points. The test was applied the same way for both feet (17,18).

Dynamic balance

The dynamic balances of the participants were evaluated with the Y balance test. For the Y balance test, to increase the repeatability of the measurements and standardize the performance in the test, instead of the 8-way Star Excursion Balance Test, its adapted version with 3 directions and 120˚ intervals was used (19). By taking the Y Balance Test Kit as an example, a wooden standing platform was used, and measuring tapes were fixed on pipes in three directions to measure the reaching distance. The participants tried to reach the farthest point with their other foot while their hands were on their waists, and they were trying to maintain balance with their dominant foot on the wooden platform. In compliance with the standardized test protocol, reaching distances were recorded with 3 repetitions each and 3 directions as anterior, posterior-medial and posterior-lateral. All tests and practices were carried out without shoes to prevent balance and stability contribution. To use in scoring, the dominant side lower extremity length was determined by measuring the distance between the iliac spine anterior superior and the medial malleolus. The mixed reaching distance was obtained with the formula: [(maximum anterior + maximum posterior-medial + maximum posterior-lateral) / (3 x lower extremity length)] x 100 (20).

Speed and agility

For assessing speed and agility in the study, the sub-test of "Stationary Jumping on Preferred Foot" of the Bruininks-Oseretsky Test of Motor Proficiency–Brief Form Second Version (BOT-2-BF) was used. For the test, the individual was asked to stand on their preferred foot by holding their hands on their waist, keep the other extremity with hips in neutral and knee at a 90-degree flexion and stand on the specified line. At this position, they were asked to jump to the right and left of the specified line on the floor for 15 seconds. A stopwatch was started and the number of correct jumps within 15

seconds was recorded. Separation of hands from the body or falling of the level of the foot was accepted as the criterion to end the test (21).

Enjoyment of physical activity

To measure the physical activity enjoyment levels of the participants in the intervention group, the Physical Activity Enjoyment Scale's Short Form (SF-PACES) was utilized. This is a 5-point Likert-type scale consisting of 18 items. SF-PACES consists of 5 items to reflect the objectives of exercise and determine enjoyment while continuing activities of exercise. The scoring changes between 1 and 5. While the items 2, 3 and 5 are scored in the form of 1=1, 2=2, 3=3, 4=4 and 5=5, the items 1 and 4 are inversely scored. The total score in the scale varies from 5 to 25. In each item in the scale, 5 points show that the individual absolutely agrees, while 1 point shows that they absolutely disagree. SF-PACES was tested for validity and reliability for 9-14-year-old Turkish children by Mirzeoğlu and Çoknaz (22).

Exergaming intervention

The participants in Intervention Group (IG) received a total of 18 sessions consisting of 30-45 minutes of EI for 6 weeks and 3 days every week on Xbox 360 Kinect™. For the participants to get used to the equipment and the intervention protocol, sufficient numbers of trials were carried out. During the trials, the feedback given by the device was utilized in terms of which part of the body to move. In addition, verbal warnings such as 'you are doing great, you are doing well, pay attention, etc.' were given by the physiotherapist to minimize mistakes during the games. In the intervention, to improve balance, weight transfer, coordination and reaction time, the games River Rush, Reflex Ridge, 20.000 Leaks, Rally Ball, Space Pop, Knock Out Punch, Funnel Cakes, Skiing, Boxing, Gold Mountain Rush and Kinect Joy Ride were selected. For the games to be more enjoyable, the participants were taken into intervention in groups of two. Before the games, the participants were informed about the purpose of the game. The selected games contained various fun movements that could help increase balance. In the games, the children perform body movements as do the characters in the virtual World such as arm movements, stepping aside and bending. The body position is carried to the outside of the support surface limits. This way, balance intervention takes place. The games were divided into weeks based on their difficulty, and the difficulty was increased each week.

For the participants to play the games on a large screen and be more immersed in the virtual environment, the content was reflected onto a wall by a projection device. The intervention was carried out in an exercise room whose floor was covered with a non-slippery material and had dimensions of 24 m2 (6m x 4m). To minimize the potential risks related to the intervention protocol, all furniture in the room were removed. For the children to get used to the games and for preventing negative events that could be encountered during the games, the children were shown videos about the games beforehand. At the end of each week, participation and acknowledgement certificates were provided to encourage the participants. Acknowledgement certificates were also given to the participants in the control group for their participation in the study at the end of the 6 weeks.

Statistical Analysis

The data were analyzed by using the IBM SPSS Statistics V.20.0.0 software. Shapiro-Wilk test was utilized to test the normal distribution of the data. As the p-values obtained with this test were smaller than 0.05, it was decided that the data were not normally distributed, and non-parametric statistical tests were used in the statistical analyses.

The significance of the difference between the means in two independent samples was examined by Mann-Whitney U test. The significance of the difference between the means in two dependent samples was examined by Wilcoxon signed-rank test. Chi-Squared and Fisher's Exact tests were used to determine the significance of the difference between two percentages.

The study presents the continuous variables as mean ± standard deviation and categorical variables as frequency and percentage. Error probability was accepted as α=0.05. Arithmetic means are presented with 95% confidence interval (95% CI) lower and upper limit values. To determine whether or not the groups were different, both p-values and

the 95% CI values were considered. Accordingly,

1. If p<0.05, and there is no overlap between the two groups' 95% CI lower and upper limits, the means are different.

2. If the 95% CI lower and upper limits of the difference between the two groups does not contain '0', the means are different (23).

The effect sizes of the interventions in the groups were calculated by using the formula r=z/√ 2. It was interpreted that r = 0.1 referred to small, r = 0.3 referred to medium and r = 0.5 referred to large effect (24).

RESULTS

The mean age of the participants was 9.7 ± 0.6 in IG and 9.5 ± 0.6 in CG. Each group included 10 female (58.8%) and 7 male (41.2%) participants. The groups were statistically similar in terms of age, sex, body weight, height and BMI values (p>0.05). The dominant lower extremity was the right one for 16 participants (94.1%) in IG and 15 participants (88.2%) in CG. The dominant lower extremities in both groups were statistically similar (p>0.05) (Table 1).

The statuses of any physical activity before the study, average daily sleeping duration, duration spent per day in front of the television or computer and days spent per week in front of the television or computer were statistically similar in both groups (p>0.05) (Table 1).

Before the intervention, the groups were found to be statistically similar in terms of their static bal-

Table 1. Demographic Characteristics of the Participants, *(% 95CI)*, (N=34)

Variable	Groups		
	Intervention Group n = 17	**Control Group n = 17**	**P Value**
Age, Year, x ± sd	9.7 ± 0.6 *(9.4 — 10.0)*	9.5 ± 0.6 *(9.2 — 9.8)*	0.536*
Gender, n (%)			
Female	10 (58.8) *(0.4 — 0.8)*	10 (58.8) *(0.4 — 0.8)*	1.000**
Male	7 (41.2) *(0.2 — 0.6)*	7 (41.2) *(0.2 — 0.6)*	
Height, m	1.4 ± 0.1 *(1.3 — 1.5)*	1.4 ± 0.1 *(1.3 — 1.5)*	0.173*
Body Weight, kg	51.5 ± 8.0 *(47.4 — 55.6)*	47.9 ± 6.9 *(44.4 — 51.4)*	0.310*
Body Mass Index, kg/m^2	24.4 ± 2.2 *(23.3 — 25.5)*	23.9 ± 2.8 *(22.5 — 25.3)*	0.408*
Dominant Lower Extremity, n (%)			
Right	16 (94.1) *(0.7 — 0.9)*	15 (88.2) *(0.7 — 0.9)*	1.000***
Left	1 (5.9) *(0.0 — 0.3)*	2 (11.8) *(0.0 — 0.3)*	
Prior Regular Physical Activity, n (%)			
Done	8 (47.1) *(0.3 — 0.7)*	9 (52.9) *(0.3 — 0.7)*	0.732**
None	9 (52.9) *(0.3 — 0.7)*	8 (47.1) *(0.3 — 0.7)*	
Sleep Time, Hours/Day, x ± sd	9.2 ± 0.6 *(8.9 — 9.5)*	8.8 ± 0.7 *(8.4 — 9.2)*	0.084*
TV-PC, Hours/Day, x ± sd	2.2 ± 0.9 *(1.7 — 2.7)*	0.7 ± 1.2 *(0.1 — 1.3)*	0.470*
TV-PC, Day/Week, x ± sd	6.5 ± 0.8 *(6.1 — 6.9)*	6.7 ± 0.9 *(6.2 — 7.2)*	0.194*

*: Mann-Whitney U Test, **: Chi-Square Test, ***: Fisher's Exact Chi-Square Test, TV:Television, PC:Personal Computer

Table 2. Comparison of Before and After Training Values of the Groups

Balance and Speed-Agility	Before Training				After Training			
	Intervention Group	Control Group	p *	Mean Differences % 95 CI	Intervention Group	Control Group	p*	Mean Differences % 95 CI
Flamingo Balance Test, Number of Falls/60sec	15.7 ± 5.9	16.5 ± 6.5	0.70	*-5.14—3.54*	12.2 ± 5.3	15.9 ± 5.9	0.10	-7.62 — *0.22*
BOMYT-2BF Speed-Agility Score	4.4 ± 2.9	5.5 ± 2.9	0.24	*-3.13—0.93*	7.8 ± 4.1	6.3 ± 3.8	0.14	-1.26 — 4.26
Y Balance Test Reach Distance, cm Score								
Anterior	48.6 ± 3.3	47.1 ± 4.4	0.39	*-1.22— 4.22*	51.9 ± 3.9	46.0 ± 4,9	**0.00**	***2.81 — 8.99***
Posterior-Medial	50.7 ± 3.5	53.5 ± 5.1	**0.04**	*-5.86—0.26*	53.2 ± 5.9	50.4 ± 5.7	0.21	*-1.25 — 6.85*
Posterior-Lateral	41.1 ± 9.5	46.8 ± 7.5	0.11	*-11.68—0.28*	49.3 ± 9.5	48.1 ± 6.8	0.35	*-4.57 — 6.97*
Composite	60.4 ± 6.6	64.4 ± 7.2	0.06	*-8.83—0.83*	65.9 ± 7.9	62.5 ± 6.2	0.08	*-1.56 — 8.36*

BOMYT-2BF: Brief Form Second Edition of Bruininks-Oseretsky Motor Proficiency Test, *: Mann-Whitney U Test, 95% CI: 95% Confidence Interval, Bolded numbers indicate that the results are statistically significant.

ance and speed-agility scores (p>0.05) (Table 2). Before the study, although there was a significant difference in the reaching distance of the groups in the posterior-medial direction in the Y balance test (p=0.036), there was no significant difference in the other directions and the mixed reaching distance (p>0.05). It was determined that the difference between the two means of the posterior-medial reaching distance in the Y balance test covered '0' in its 95% CI. Therefore, the difference was insignificant (Table 2).

When the groups were compared after the study in terms of their static and dynamic balance and speed agility test results, there was a significant difference only in the anterior reaching distance in

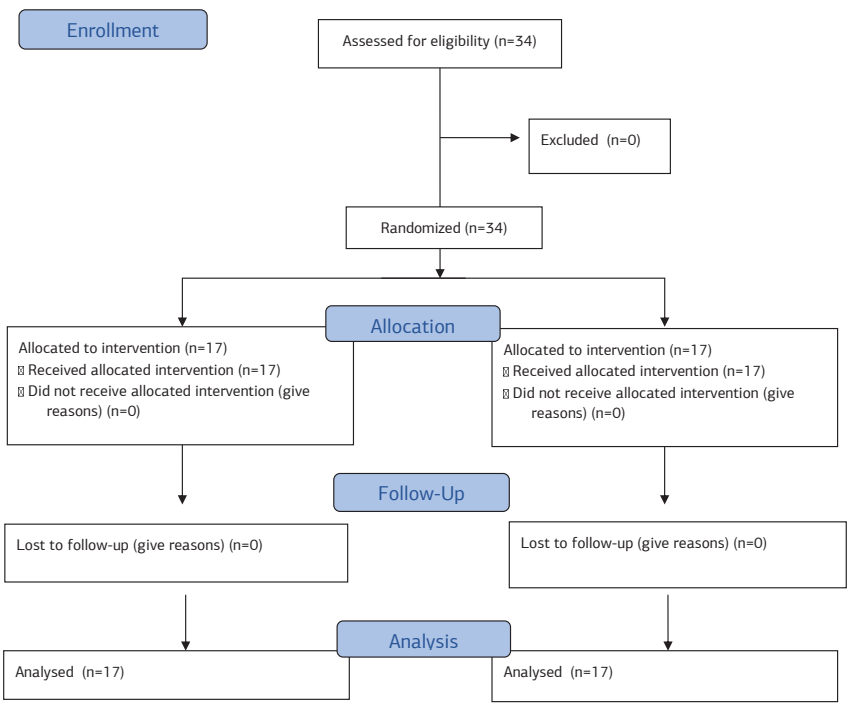

Figure 1. Flow chart of the study

Table 3. Comparison of Pre-Test and Post-Test Values of the Groups

Balance and Speed-Agility	Intervention Group (n=17)					Control Group (n=17)				
	Pre-Training	Post-Training	P *	Mean Differences % 95CI	r **	Pre-Training	Post-Training	P *	Mean Differences % 95CI	r**
Flamingo Balance Test, Number of Falls/ 60sec	15.7 ± 5.9	12.2 ± 5.3	**0.00**	-0.42 — 7.42	**0.6**	16.5 ± 6.5	15.9 ± 5.9	0.49	-3.74 — *4.94*	0.1
BOMYT-2BF Speed-Agility Score	4.4 ± 2.9	7.8 ± 4.1	**0.00**	**-5.88 — -0.92**	**0.6**	5.5 ± 2.9	6.3 ± 3.8	0.12	-3.16—*1.56*	0.3
Y Balance Test Reach Distance, cm										
Anterior	48.6 ± 3.3	51.9 ± 3.9	**0.01**	***-5.82 — -0.78***	0.4	47.1 ± 4.4	46.0 ± 4.9	0.24	-2.15—*4.35*	0.2
Posterior-Medial	50.7 ± 3.5	53.2 ± 5.9	0.14	*-5.99 — 0.79*	0.3	53.5 ± 5.1	50.4 ± 5.7	**0.01**	*-0.68—6.88*	0.4
Posterior-Lateral	41.1 ± 9.5	49.3 ± 9.5	**0.00**	***-14.84 — -1.56***	**0.6**	46.8 ± 7.5	48.1 ± 6.8	0.19	*-6.30—3.70*	0.2
Composite	60.4 ± 6.6	65.9 ± 7.9	**0.00**	***-10.59 — -0.41***	**0.5**	64.4 ± 7.2	62.5 ± 6.2	0.12	*-2.79—6.59*	0.3

BOMYT-2BF: Brief Form Second Edition of Bruininks-Oseretsky Motor Proficiency Test, *: Wilcoxon Sign Test, 95% CI: 95% Confidence Interval, **: Rosenthal Effect Size, Bolded numbers indicate that the results are statistically significant.

the Y balance test (p=0.001, 95% CI: 2.81 — 8.99). However, no significant difference was found for all other directions (p>0.05) (Table 2).

The BOT-2-BF speed-agility scores and the Y balance test anterior, posterior-lateral and mixed reaching distances of the participants in IG significantly increased after the intervention in comparison to their preintervention values (p<0.05). While the Flamingo balance test result also significantly increased in this group in comparison to the pre-intervention values (p=0.001), when the 95% CI results were examined, this increase was found to be insignificant (-0.42—7.42). The effect sizes for these variables were in the range of 0.3-0.6 (Table 3).

There was no statistically significant difference between the pre-intervention and post-intervention Flamingo balance test and BOT-2-BF scores of the participants in CG (p>0.05). The effect sizes for these variables were in the range of r=0.1-0.4. In terms of the Y balance test reaching distances, there was a significant difference only in the posterior-medial reaching distance (p<0.05). However, when the posterior-medial reaching distance was considered with the 95% CI, it was seen that the lower and upper limits were overlapped, and the difference between the two means covered the value of '0'. This is why the difference that was obtained was insignificant. For the other directions, the intragroup comparisons revealed no significant difference (p>0.05) (Table 3).

All participants in IG stated that they enjoyed EI very much. All participants gave the highest score for EI, which was 25 (95% CI: 25.0 —25.0).

DISCUSSION

As a result of the study, it was determined that EI that was applied for 6 weeks with 9-11-year-old obese children by using the Xbox 360 Kinect™ device improved static and dynamic balance and speed-agility. All children that received EI had high levels of satisfaction with the intervention. Balance is a complex process that contains multidirectional sensorimotor and biomechanical components. Complicated systems such as the somatosensorial and sensorimotor systems are dominant in achieving postural control. During normal standing up straight, postural control is primarily obtained from visual sources and proprioceptive feedback coming from the lower extremities. As sensory information decreases, postural control also decreases (25). Studies have revealed that postural release is increased in obese children, and projected acts cannot be modulated fast (7,26). McGraw et al. used a strength platform for postural stability analysis and made center of pressure (COP) measurements. During standing, there are a higher rate of reduction in postural stability in obese prepubertal males in comparison to non-obese ones. In the COP measurement in obese prepubertal males, it was seen that especially instability in the medio-later-

al direction significantly increased (27). During EI, children see their own virtual profiles on the screen and move accordingly. At this point, children constantly make adjustments in their center of gravity to be able to reach their goals, and this contributes substantially to the change that occurs in relation to balance (28). The study by Beaulieu-Boire et al. included three adult subjects with balance problems. In addition to the physiotherapy program of 10 weeks including 2 days per week for 30 minutes each season, EI was applied with games that aimed to improve balance named 'Kinect Games, Kinect Sports, Kinect Adventures, Your Shape Fitness Evolved and Carnival'. As a result, it was reported that EI applied with Xbox 360 Kinect™ significantly contributed to improvement of balance (29). In our study, there was an improvement in static and dynamic balance and increase in speed-agility among the obese children who received EI. In our study, no statistically significant change was found in the posterior-medial reach distances in the Y balance test in the EI group after the intervention. Performance in the Y balance test is affected by trunk and lower extremity kinematics. Especially hip flexion is the best predictor of performance in the posterior direction. In our study, there were no data on hip flexion and trunk kinematics. This may have had an effect on our results. Therefore, it is recommended that trunk and lower extremity kinematics should also be analyzed during Y balance test in future studies (30). However, the lack of change in posterior-medial access distance may also be due to the games used. Therefore, it may be useful to use different games in future studies.

In our study, there was an improvement in static and dynamic balance and increase in speed-agility among the obese children who received EI. The clinical effects were moderate-large. In CG, which received no intervention, the clinical effect of the change was small-moderate for static and dynamic balance and moderate for speed-agility. In other words, there were also improvements in the balance and speed-agility of the children who did not receive any intervention, although these changes were smaller. If children are encouraged to learn motor skills, their motor skills show a faster development stage than what is expected of their age (31). In this context, it may be stated that, with exergaming games that increase postural stability and control as a result of biomechanical effects, both balance and speed-agility skills may be improved better. Van Bijon et al. used the short version of the Bruininks-Oseretsky Competence test for motor competence in 30 overweight and obese children. The study group received a 6-minute active video intervention using Nintendo Wii for 30 minutes per session, 3 days a week. There were two control groups in the study. One of the control group played traditional video games and the other group was asked to continue their daily life activities without any intervention. The study group that played active video games showed improvements in motor competence, especially in terms of agility and speed (32). Similarly, in our study, Exergame was applied for a total of 6 weeks, and the control group was asked to continue their daily lives without any intervention. When examined in terms of speed and agility in our study group, it was determined that there were both statistically and clinically significant improvements. Although statistical significance was not detected in the control group, the fact that a small-moderate clinical effect was found may be a result of continuing their daily physical activities. This result indicates that active video games are an effective tool in correcting speed and agility, which is one of the indicators of motor competence in children and adolescents. Therefore, it can be used as an alternative tool to traditional exercises to improve health during childhood. Moreover, clinical effect may be increased by longer-term intervention strategies (33). The main change in dynamic balance took place in the mixed, anterior and posterior-lateral directions. The requirement of the games to move fast and immediately and have coordination and their characteristics may have been affective on the outcomes. However, to reach a precise judgement, biomechanical analyses on games should be carried out. When the results of our study were analyzed, it was found that the difference between the groups in the Y balance test was found only in the anterior reach distance. Reach distances in the Y balance test may be affected by various factors. There are studies showing that the reach distance especially in the anterior direction is related to the normal range of motion and flexibility of the ankle joint (34,35). The fact that no evaluation was made

for these in our study prevents us from making a judgment in this direction. However, we think that it would be useful to examine flexibility and range of motion values in the lower extremity when Y balance test results are analyzed in future studies. The nature of the games used in our study may also have had an impact on our results.

Nowadays, posturography measurement is accepted as the gold standard measurement for balance assessments. Computerized posturography was to provide a detailed and quantitative assessment of the motor system and the central processing of inputs from the vestibular, visual, somatosensory systems related to postural stability. However, posturography measurements were not used in our study because they are expensive and not available in our university.

Sheehan and Katz reported that traditional physical activity programs and active video games that aimed to improve balance, agility and coordination in 3rd-grade primary school students had similar effects in improving balance. Based on this result, the authors stated that Wee Fit +™ helped improve balance (36). Daniel et al. reported that comparing traditional treadmill exercise training with exercise game in university students, higher enjoyment of exercise game and less perceived exercise rating. Based on this result, the authors stated that exergaming is an attractive and effective option for students to participate in physical activity (37).

Studies have reported that, when obese children take part in physical activity through active video games, they enjoy the physical activity more (38,39). In our study, it was seen that the children who participated in EI were satisfied with the intervention to the maximum extent. In this context, it is believed that EI's are a highly motivating physical activity option to direct obese children towards physical activity. Based on this reality, applying exergaming in an integrated way with routine physiotherapy programs may contribute to the solution of problems related physical inactivity. Additionally, it may help planning the treatment process by providing the physiotherapist with a new point of view.

The most important limitation of our study was that the participants were not selected from a population containing obese children based on the national health and population data. This prevents the generalization of the results. Nevertheless, to the best of our knowledge, there is no such pool of data in the Northern Cyprus.

Although the time spent passively (such as TV and computer time) was similar in both groups, the fact that physical activity levels were not determined is a limitation of our study. In this context, it is thought that it will be useful to determine the level of physical activity in future studies in order to make a definite judgment.

Another limitation of the study is the lack of normative values of the Y balance test for the measurement of lower extremity dynamic balance for children aged 9-11 years participating in our study. This makes it difficult to interpret the results obtained from the Y balance test. Therefore, obtaining normative values for children in this age group in future studies will lead to a more objective interpretation of the results. Therefore, more detailed information can be obtained by using computerized posturography measurements for balance assessment.

In our study, Bruininks-Oseretsky Motor Proficiency Test was used to measure speed and agility. In this test, only the ability to jump to the right and left of a line drawn on the ground for 15 seconds is tested. Therefore, it is recommended to use other tests to get detailed information about speed and agility.

6 weeks of EI applied on obese children is effective in improving static and dynamic balance and speed-agility. Considering in this context, EI may be recommended for improving balance to be used as a part of physical education courses and spare time activities based on the interests of children in their pre-adolescent period.

Additionally, as EI is a physical activity that is enjoyed by children, it is a good alternative for directing obese children to physical activity. Furthermore, it should be kept in mind that turning physical activity into a lifestyle requires longer intervention duration. For this reason, the large randomized controlled studies with long-term interventions and follow-up are recommended.

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Author Contributions: The subject of the study and the research design were determined by three authors. Data collection was done by the first author. The manuscript has been written, read, and approved by all the authors. Three authors were involved in analyzing the data and reporting the study.

Explanations: It is a study produced from the master's thesis completed by the first author

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Neriman TEMEL AKSU, PT[1]
Abdullah ERDOĞAN, Prof. MD.[2]

EXAMINING THE EFFECTS OF CONNECTIVE TISSUE MASSAGE ON PAIN AFTER THORACOTOMY - RANDOMIZED CONTROLLED TRIAL

ORIGINAL ARTICLE

ABSTRACT

Purpose: The objective was evaluate the effect of a connective tissue massage on pain, applied analgesic amounts and length of hospitalization of the patients.

Method: The study was a prospective, randomized, controlled clinical trial and conducted at a thoracic surgery department of university hospital. The patients were randomly allocated to 1 of 2 groups: a control group (n=27) and the experimental group (n=27). Standard medical treatment, care and pulmonary rehabilitation program were applied to both groups. In addition, a total of 5 sessions of connective tissue massage were applied to the experimental group. Pain level of the patients was evaluated at every 24 hours as of the zeroth postoperative day. VAS was used as a one-dimensional scale for pain assessment. Totally applied analgesic amounts and length of hospitalization of the patients were recorded.

Results: There was no statistically significant difference between the experimental and control groups on the postoperative 0th and 1st days. A statistically significant difference was found between VAS averages on postoperative 2nd, 3rd, 4th, 5th, 6th and 7th days ($p<0.001$). Totally applied analgesic amounts of the the patients decreased significantly from the postoperative 2nd day ($p<0.05$). The length of hospital stay in the experimental group was short.

Conclusions: The pain of the experimental group decreased significantly and their pain on the postoperative 7th day was quite low and therefore the need for analgesic drugs decreased significantly.

Key words: Connective tissue massage, Pain, Quality of life, Thoracotomy.

TORAKOTOMİ SONRASI KONNEKTİF DOKU MASAJININ AĞRI ÜZERİNDEKİ ETKİSİNİN İNCELENMESİ - RANDOMİZE KONTROLLÜ ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Konnektif doku masajının hastaların ağrılarına, uygulanan analjezik miktarlarına ve hastanede kalış sürelerine etkisinin değerlendirilmesi amaçlandı.

Yöntem: Çalışma prospektif, randomize, kontrollü bir klinik çalışmaydı ve bir üniversite hastanesinin göğüs cerrahisi bölümünde yürütüldü. Hastalar rastgele 2 gruptan 1'ine ayrıldı: bir kontrol grubu (n=27) ve çalışma grubu (n=27). Her iki gruba da standart medikal tedavi, bakım ve pulmoner rehabilitasyon programı uygulandı. Ayrıca çalışma grubuna toplam 5 seans konnektif doku masajı uygulandı. Hastaların ağrı düzeyi postoperatif 0. günden itibaren 24 saatte bir değerlendirildi. Ağrı değerlendirmesi için tek boyutlu bir ölçek olarak VAS kullanıldı. Hastaların toplam uygulanan analjezik miktarları ve hastanede kalış süreleri kaydedildi.

Sonuçlar: Cerrahi sonrası 0. ve 1. günlerde çalışma ve kontrol grupları arasında istatistiksel olarak anlamlı fark yoktu. Postoperatif 2., 3., 4., 5., 6. ve 7. günlerde VAS ortalamaları arasında istatistiksel olarak anlamlı fark bulundu ($p<0,001$). Hastaların toplam uygulanan analjezik miktarları postoperatif 2. günden itibaren anlamlı olarak azaldı ($p<0,05$). Çalışma grubunda hastanede kalış süresi kısaydı.

Tartışma: Çalışma grubunun ağrıları anlamlı olarak azaldı ve postoperatif 7. gün ağrıları oldukça azdı ve bu nedenle analjezik ilaç ihtiyacı önemli ölçüde azaldı.

Anahtar kelimler: Ağrı, Konnektif doku masajı, Torakotomi, Yaşam kalitesi

1 *Department of Physical Therapy and Rehabilitation, Akdeniz University, Antalya, Turkey*
2 *Department Of Thoracic Surgery, Akdeniz University Faculty Of Medicine, Antalya, Turkey*

Correspondence (İletişim):

Neriman TEMEL AKSU
Department of Physical Therapy and Rehabilitation, Akdeniz University, Antalya, Turkey
nerimantemelaksu@akdeniz.edu.tr
ORCID:0000-0001-7455-8697

Abdullah ERDOĞAN
E-mail:abdullaherdogan@akdeniz.edu.tr
ORCID: 0000-0002-5299-441X

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INTRODUCTION

Acute postoperative pain continues as refractory pain after a major surgery such as thoracic surgery. Massage is a manual therapy method with proven efficiency in reducing pain in the postoperative period. Connective tissue massage, which is one of the massage types, can provide relief in the patient due to its effects (1).

Today, the most preferred method for the patients undergoing thoracotomy is seen as multimodal analgesic methods in addition to the traditional analgesic medications and it is considered as the golden standard (2).

Non-pharmacological methods can be classified as physical, cognitive, behavioral, other complementary methods or invasive and non-invasive methods (3).

Massage is an adjuvant therapy that can be safely applied to relieve pain in the acute postoperative period after major operations. Massage reduces anxiety, stabilizes the condition of the patient and improves the coping skill to in the intensive care unit (4,5).

Connective tissue massage was developed by the German physiotherapist Elizabeth Dicke in 1935. Connective tissue massage is a manual therapy technique performed by stretches on connective tissue. The stretches are made on the places where the fascia adheres to the bone or where the fascia is superficial (6). Connective massage is slightly different from classical manipulative treatment approaches in terms of its application technique and physiological effects. It is thought that classical massage acts as presynaptic inhibitions and connective tissue massage as postsynaptic inhibitions on pain. (7,8).

Massage changes the blood flow, causing psychological relaxation and reduction of pain. Tactile information from massage can stimulate large-fast nerve fibers and then block smaller-slow nerve fibers that detect pain. This effect is likely due to local lateral inhibition in the spinal cord, which may explain why touching a painful area is an effective strategy for relieving pain (9).

Connective tissue massage is a type of massage that focuses on stretching the connective tissue layers. There are various theories about connective tissue massage. One theory is that tension applied to connective tissue may stimulate cutaneous-visceral reflexes via the autonomic nervous system and produce healing effects on internal organs that share the same innervation as dermatomes in the skin. At the same time, connective tissue massage reduces pain, increases collateral circulation and mobility, and affects the autonomic nervous system by reducing muscle spasms (6,7).

The aim was to evaluate the effect of connective tissue massage after thoracotomy on patients' pain, the amount of analgesics applied, and their hospital stay.

METHODS

Study design

This study was planned as a randomized controlled prospective study on "The Effects of Connective Tissue Massage Application on Pain After Thoracotomy".

This research was conducted in Akdeniz University Hospital Thoracic Surgery Intensive Care Unit and Thoracic Surgery Service between August 2017 and January 2018. The research was approved by Akdeniz University Clinical Research Ethics Committee (dated 03.05.2017, numbered 70904504/170-6). The written informed consent was signed by every participant. The study was conducted in accordance with the principles ofthe Declaration of Helsinki.

Participant selection

Inclusion Criteria of the Study

• Applying to Thoracic Surgery Department of University Hospital and undergoing thoracotomy via posterolateral thoracotomy incision,

• Being in age range of 20-75 years,

• Being stable in terms of hemodynamics,

• Having no metastatic dissemination,

• Having no cognitive impairment that may inhibit communication,

• Agreeing to participate in the study.

Exclusion Criteria for the Study

• Having cardiovascular diseases,

• Having more than 200 cc bleeding per hour from the drainage tubes,

• Having an intubation period longer than 24 hours.

Randomization

The patients were randomly divided into two groups as the control group and the experimental group by using the Microsoft Excel program. The first group of the study consisted of the patients in the control group and the second group consisted of the connective tissue massage group.

Sample size calculation

The sample of the study was determined by the PS Power and Sample Size Calculations Version 3.0 program. Accordingly, the number of patients targeted to be reached in the sample with the power of 95% and 0.05 Type I error was planned a total of 54 patients including at least 27 controls (11).

Interventions

Standard medical treatment, care and pulmonary rehabilitation program were applied to both groups. In addition, a total of 5 sessions of connective tissue massage were applied to the experimental group as 1 session a day on the postoperative 1st day, 2nd day, 3rd day, 4th day, 5th day. The connective tissue massage was started from the lumbosacral region (baseline) and was applied to the lower thoracic, scapular, inter-scapular and cervico-occipital region according to the vascular response of the connective tissue (12).

Outcome measures

VAS (Visual Analogue Scale) was used as a one-dimensional scale for pain assessment. The scale is 10 centimeters long. A value of 0 at the left end of the scale indicates no pain, and a value of 10 at the right end indicates unbearable pain. The patient is asked to mark a point on a vertical or horizontal line that matches his or her pain level. The distance between the marked point and the far left end of the line is measured in centimeters and the obtained value is recorded. This value shows the patient's pain intensity. 0 indicates no pain, 1-3 indicates mild pain, 4-6 indicates moderate pain, and 7-10 indicates severe pain (13). Sensitivity and selectivity evaluations of VAS were made and it was decided that it could be used (14). On postoperative 0th day, 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day (before the massage in the experimental group) (between 8:00 and 9:00 in the morning); in other words, pain level of the patients (n=54) was evaluated at every 24 hours as of the zeroth postoperative day.

Totally applied analgesic amounts of the patients were recorded on the postoperative 0th day, 1st day, 2nd day, 3rd day, 4th day, 5th day, 6th day, and 7th day. In addition, length of hospitalization of the patients was recorded.

Statistical analysis

The data were analyzed in the SSPS (Statistical Package for Social Sciences) (IBM Electronics, ABD) 21.0 program. Shapiro Wilks Test was used to determine the suitability of the variable for normal distribution in the study and control groups. When $p<0.05$, it was decided that the normal distribution of the data was not appropriate and nonparametric tests were applied.

In order to analyze the difference between the mean values of the numeric data between two groups, Mann Whitney-U Test were used. In the evaluation of the difference between the pre-test and post-test mean values of the data, Wilcoxon T Test were used. The Friedman test was used to examine the changes in the amount of pain and analgesic drugs used by the groups according to the days. Correlation coefficients were calculated in order to determine the relationship between demographic, clinical characteristics demographic characteristics of patients and VAS scores, applied analgesic amounts of the patients.

RESULTS

Baseline characteristic

65 patients who were hospitalized before the surgery were evaluated. 6 patients were not eligible for study and 5 patients did not want to participate in the study. Trial flow is presented in Figure 1. There was no significant difference between the groups in terms of age, gender, BMI, marital status, educational status, smoking, chronic diseases, type of surgery, duration of mechanical ventilation,

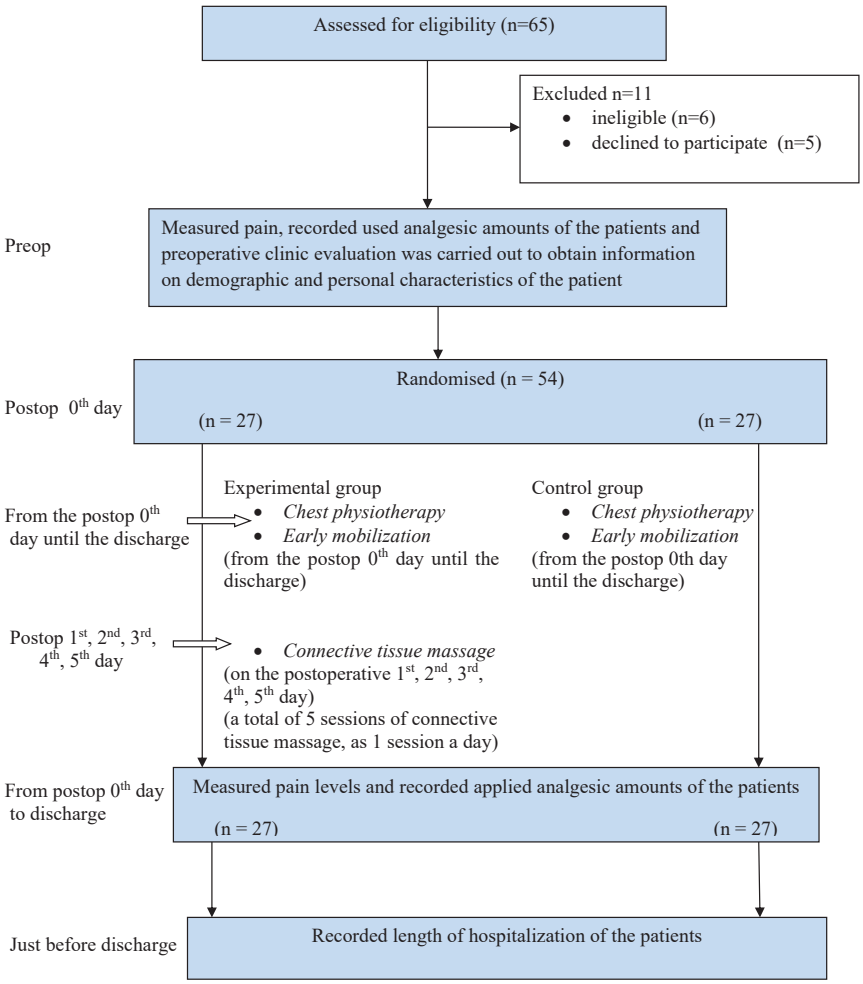

Figure 1. CONSORT Flow Diagram

duration of stay in intensive care unit, preoperative pain level and preoperative applied analgesic amounts of the patients (p>0.05) (Table 1).

Outcome measures

As seen in Figure 2 VAS scores of the patients in the experimental group was statistically lower than the control group on the postoperative 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day (p<0.001). There was a statistically significant improvement in intra-group change analysis VAS scores in the both group (p<0.001) (Figure 2).

The applied tramadol amounts of the patients in the experimental group was statistically lower than the control group on the postoperative 2nd day, 3rd day, 4th day, 5th day, 6th day and 7th day (p<0.005) (Table 2).

The length of hospitalization of the patients in the experimental group was 8.07 ± 0.27 days and in patients in the control group was 8.74 ± 0.98 days. The length of hospitalization of the patients was significantly higher in the control group (p=0.001) (Table 2).

Pain level of the patients

Patients with longer hospitalization had more pain scores on the 5th and 7th postoperative days (p<0.005) (Table 3).

The applied analgesic amounts of the patients

The applied tramadol and diclofenac amounts of the patients on postoperative 0th day was higher in patients with higher BMI (p<0.005). Patients with more hospitalization in the intensive care unit had higher tramadol use on postoperative 5th and

Table 1. Demographic and Clinical Characteristics of the Patients

	Experimental Group		Control Group		p
	n	%	n	%	
Gender					1.000
Female	7	25.9	7	25.9	
Male	20	74.1	20	74.1	
Marital status					0.704
Married	22	81.5	24	88.9	
Single	5	18.5	3	11.1	
Educational status					0.500
Primary Education	5	18.5	5	18.5	
Secondary Education	17	63	18	66.7	
University	5	18.5	4	14.8	
Smoking					
Not Smoke	16	59.3	18	66.7	0.779
Less Than One Pack a Day	5	18.3	5	18.3	
More than One Pack a Day	6	22.2	4	14.8	
Chronic Diseases					
Hypertension	18	66.7	20	74.1	
Chronic Pulmonary Disease	24	88.9	24	88.9	
Diabetes	22	81.5	21	77.8	
Hyperlipidemia	22	81.5	20	74.1	
Surgery					
Wedge Resection	11	40.7	10	37	
Segmentectomy	2	7.4	2	7.4	
Lobectomy	10	37	10	37	
Bilobectomy	1	3.7	2	7.4	
	Mean ± SD		**Mean ± SD**		
Body Mass Index (kg/m²)	24.44±0.85		24.46±0.80		0.910
Duration of Mechanical Ventilation (minutes)	127.04±22.33		127.22±27.43		0.978
Age (years)	55.37±2.01		55.78±2.25		0.782
VAS Preop	0.04±0.09		0.05±0.09		0.808
Tramadol Preop (mg)	0.00±0.00		0.00±0.00		1.000
Diklofenac Preop (mg)	0.00±0.00		0.00±0.00		1.000
Morfin Preop (mg)	0.00±0.00		0.00±0.00		1.000
Paracetamol Preop (mg)	0.00±0.00		0.00±0.00		1.000

kg: Kilogram, m: Meter, mg: Milligram, n: Number of patients, SD: Standart deviation.

7th days (p<0.001) (Table 4). The applied tramadol amounts of the patients on the postoperative 3rd day decreased in patients with prolonged mechanical ventilation (r=-0.280 p=0.041). In addition, the applied tramadol amounts of the patients on postoperative 5th day and 7th day was higher in patients with longer hospitalization (p<0.005) (Table 4).

DISCUSSION

This is the first randomized controlled trial investigating the effects of connective tissue massage applied after thoracotomy. Our results showed that connective tissue massage had a positive effect on pain, analgesic drug use, and hospital stay. Although analgesics are necessary in the treatment of postoperative pain, they may not always relieve pain sufficiently.

New drugs and methods for postoperative pain control have been developed in the last 20 years. However, some studies have found these new drug treatments inadequate. Additionally, analgesics may have undesirable side effects. Therefore, non-drug treatment methods may be preferred in the treatment of acute pain after surgery. This situation makes complementary treatments and interventions more important and necessary (15).

In connective tissue massage, a short-term and painful stimulus applied from the periphery activates large-diameter A fibers. These higher-level inputs can inhibit pain through presynaptic inhibition. In other words, connective tissue massage can prevent the feeling of pain from reaching the conscious level (16,17). Celenay et al. They stated that connective tissue massage was more effective than placebo massage in reducing pain in patients

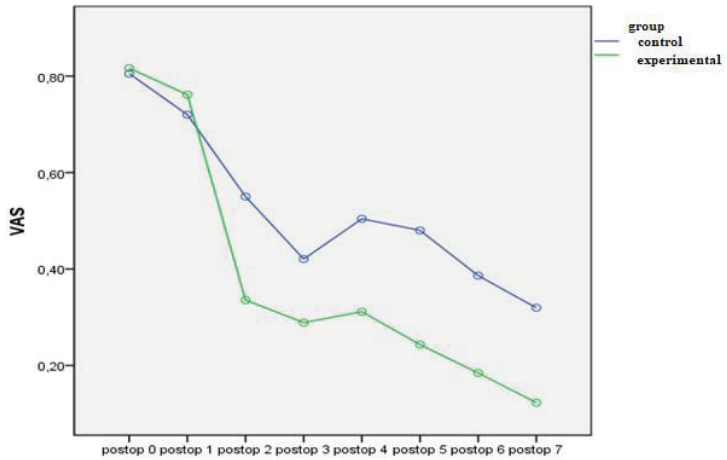

Figure 2. Time-dependent VAS Change During Rest in the Study and Control Groups

Table 2. Applied Analgesic Amounts of the Patients for Both Groups During the Trial

Applied Analgesic Amounts (mg)	Experimental Group	Control Group	Inter-Group Changes	Intra Group Changes	
	Mean ± SD	Mean ± SD	p	Experimental Group p	Control Group p
Tramadol 0	296.30±19.25	296.30±19.25	1.000		
Tramadol 1	288.89±32.03	288.89±32.03	1.000		
Tramadol 2	92.59±67.52	233.33±82.21	**<0.001***		
Tramadol 3	50.26±97.11	100.00±103.77	0.088	**<0.001****	**<0.001****
Tramadol 4	14.81±36.20	59.26±57.24	**0.002***		
Tramadol 5	7.41±26.69	51.85±57.98	**0.001***		
Tramadol 6	3.70±19.25	51.85±50.91	**<0.001***		
Tramadol 7	3.70±19.25	48.15±50.92	**<0.001***		
Diclofenac 0	138.46±3.,81	138.89±40.03	0.692		
Diclofenac 1	86.54±62.54	113.89±56.47	0.072		
Diclofenac 2	28.85±52.29	83.33±56.33	**<0.001***		
Diclofenac 3	20.19±40.01	108.33±52.35	**<0.001***	**<0.001****	**<0.001****
Diclofenac 4	28.85±56.43	108.33±66.87	**<0.001***		
Diclofenac 5	34.62±57.04	111.11±63.67	**<0.001***		
Diclofenac 6	17.31±32.23	105.56±69.80	**<0.001***		
Diclofenac 7	17.31±48.88	77.78±76.38	**0.001***		
Morfin 0	4.44±1.33	4.44±3.20	0.950		
Morfin 1	0.00±0.00	0.37±1.33	0.153		
Morfin 2	0.00±0.00	0.00±0.00	1.000		
Morfin 3	0.00±0.00	0.00±0.00	1.000	**<0.001****	**<0.001****
Morfin 4	0.00±0.00	0.00±0.00	1.000		
Morfin 5	0.00±0.00	0.00±0.00	1.000		
Morfin 6	0.00±0.00	0.00±0.00	1.000		
Morfin 7	0.00±0.00	0.00±0.00	1.000		
Paracetamol 0	0.00±0.00	111.11±211.83	0.010		
Paracetamol 1	18.52±96.23	55.56±160.28	0.303		
Paracetamol 2	0.00±0.00	55.56±160.13	0.077		
Paracetamol 3	18.52±96.23	129.63±223.29	**0.023***	0.744	0.456
Paracetamol 4	18.52±96.23	111.11±211.83	**0.045***		
Paracetamol 5	18.52±96.23	74.07±181.01	0.077		
Paracetamol 6	0.00±0.00	55.56±160.13	0.163		
Paracetamol 7	0.00±0.00	55.56±160.13	0.077		
Length of Hospitalization (days)	8.07±0,27 (8-9)	8.74±0.98 (8-12)	**0.001***		

Abbreviation: mg: Milligram, SD: Standard deviation. *p<0.05, Mann Whitney-U Test: Difference between experimental and control group. **p<0.05, Friedman Test: The Changes in the amount of pain and analgesic drugs used by the groups according to the days.

Table 3. Pain Level of the Patients According to Their Demographic and Clinical Characteristics

		VAS			
		Postop 0	**Postop 3**	**Postop 5**	**Postop 7**
Age *Statistical evaluation*		r:-0.205 p:0.137	r:-0.144 p:0.298	r:-0.146 p:0.684	r:-0.146 p:0.293
Gender					
	Kadın	0.81±0.07	0.35±0.15	0.35±0.11	0.23±0.13
	Erkek	0.81±0.09	0.36±0.11	0.37±0.16	0.22±0.14
Statistical evaluation		p:0.883	p:0.987	p:0.600	p:0.648
Body mass index *Statistical evaluation*		r:-0.180 p:0.194	r:0.078 p:0.574	r:-0.025 p:0.857	r:0.015 p:0.913
Surgery					
	Wedge resection	0.84±0,09	0.36±0,12	0.35±0,14	0.20±0,14
	Segmentectomy	0.81±0,07	0.39±0,13	0.42±0,25	0.28±0.22
	Lobectomy	0.80±0.08	0.35±0.11	0.36±0.15	0.23±0.12
	Bilobectomy	0.77±0.09	0.42±0.27	0.33±0.12	0.12±0.13
	Pneumonectomy	0.79±0,07	0.31±0,11	0.38±0,09	0.27±0,11
Statistical evaluation		p:0.163	p:0.719	p:0.962	p:0.731
Duration of stay in intensive care unit *Statistical evaluation*		r:-0.068 p:0.624	r:0.147 p:0.287	r:0.058 p:0.679	r:0.144 p:0.299
Duration of mechanical ventilation *Statistical evaluation*		r:0.063 p:0.651	r:0.154 p:0.268	r:-0.030 p:0.831	r:-0.108 p:0.436
Length of hospitalization *Statistical evaluation*		r:-0.235 p:0.121	r:0.191 p:0.167	**r:0.399 p:0.003***	**r:0.374 p:0.005***

Abbreviation: postop: Postoperative, VAS: Visual analog scale. * p<0.05; test: pearson correlation coefficient.

Table 4. The Applied Analgesic Amounts of the Patients According to Their Demographic and Clinical Characteristics

	Tramadol				**Diklofenac**			
	Postop 0	**Postop 3**	**Postop 5**	**Postop 7**	**Postop 0**	**Postop 3**	**Postop 5**	**Postop 7**
Age *Statistical evaluation*	r:-0.003 p:0.982	r:-0.061 p:0.659	r:-0.079 p:0.569	r:-0.022 p:0.876	r:0.013 p:0.926	r:-0.106 p:0.446	r:0.128 p:0.355	r:-0.037 p:0.790
Body mass index *Statistical evaluation*	**r:0.302 p:0.026**	r:-0.061 p:0.662	r:-0.014 p:0.918	r:-0.122 p:0.379	**r:0.422 p:0.002***	r:0.103 p:0.458	r:0.194 p:0.160	r:0.160 p:0.248
Duration of stay in intensive care unit *Statistical evaluation*	r:0.174 p:0.208	r:-0.108 p:0.438	**r:0.558 p<0.001***	**r:0.742 p<0.001***	r:-0.083 p:0.552	r:0.026 p:0.849	r:-0.033 p: 0.813	r:-0.108 p:0.435
Duration of mechanical ventilation *Statistical evaluation*	r:0.006 p:0.964	**r:-0.280 p:0.041***	r:-0.217 p:0.115	r:-0.027 p:0.845	r:-0.005 p:0.974	r:-0.145 p:0.295	r:-0.109 p:0.434	r:-0.034 p:0.805
Length of hospitalization *Statistical evaluation*	r:-0.132 p:0.341	r:0.095 p:0.505	**r:0.280 p:0.040***	**r:0.326 p:0.016***	r:-0.230 p:0.094	r:0.063 p:0.650	r:0.020 p:0.883	r:-0.098 p:0.480

Abbreviation: postop: Postoperative. * p<0.05; test: pearson correlation coefficient.

with chronic low back pain (18). After thoracotomy, the pain is quite severe due to the wide distribution of the intercostal nerves and the cutting of more muscle mass (19). Pain control not only reduces the feeling of pain but also reduces the complications and accelerates the healing process. Patients with chronic postoperative pain after traditional thoracotomy received insufficient pain treatment during hospitalization (20,21).

Various techniques providing post-thoracotomy pain management have been described, but there has been still no internationally accepted best strategy. Opioid is easy to use and is the most common method used to provide analgesia. However, this may have some unwanted side effects such as respiratory depression, vomiting, nausea, ileus and urinary retention (22). Epidural analgesia can be an ideal method for thoracotomy pain management. However, it has not been proven to reduce pulmo-

nary function and pulmonary complications (23).

Non-pharmacological applications are included in routine patient care. In 2007, it was observed that 37.4% of the hospitals in the United States of America were using one or more non-pharmacological therapies. Most of these therapies focus on pain and anxiety. Therefore, these therapies aim to help the needs that cannot be met by traditional approaches in the postoperative period. Especially, massage therapy seems a rational choice in the postoperative period. Massage is effective in significantly reducing postoperative pain in patients with major thoracoabdominal surgeries and cholecystectomy, appendectomy (24,25).

Massage has gained widespread popularity for pre-operative anxiety management and pain management in hospitalized patients. However, massage is mostly used for pain relief. Massage relieves anxiety and pain, but the mechanism of action is not yet understood. Many scientists have suggested that massage works to alleviate anxiety by promoting relaxation and working on the subconscious to encourage positive emotions. Similarly, massage can relieve pain by producing a localized effect on the muscles and activating unmyelinated C fibers that block the perception of pain. Despite the popularity of massage for pain management among postoperative patients who have had heart surgery and thoracic surgery, only a few types of massage have been used to treat pain in women who have had breast surgery (26).

One study shows that massage therapy can be successfully integrated into thoracic surgery practices. Based on these findings, massage therapy has been shown to provide both subjective and objective benefits to thoracic surgery patients in terms of improved pain management. In a hospital setting, massage therapy needs to focus on individual patient symptoms, and then therapy is individualized based on these symptoms, medical condition, and position tolerance. There are potential benefits to adding complementary therapies, such as massage and potentially other mind-body therapies, to a pain management program in the hospital setting (27).

Although there is evidence to support the pain-relieving effects of massage in cardiac surgery patients, few studies have been conducted in the intensive care unit where pain intensity is highest. Given the complexity and severity of pain in the ICU, future rigorous randomized controlled trials are needed to evaluate the effect of massage on the pain intensity of critically ill adults. In addition, studies are needed to evaluate the effects of massage such as pain distress and pain interference, which are other dimensions of pain, and the use of opioids during hospitalization. Reducing opioid use may improve patients' recovery by reducing opioid-related side effects (28).

Massage therapy has been studied in many clinical settings and found to be valid. It has been proven that the massage applied to cancer patients has symptomatic benefits. Massage was applied to 605 postoperative patients for 20 minutes per day for 5 days. As a result of the study, the pain intensity, short-term anxiety, opioid use, and hospitalization periods of the patients decreased. However, no effect was observed on long-term anxiety (5).

It has been proven that postoperative massage in the patients undergoing cardiac surgery has provided physical and psychological benefits during their hospitalization periods. Massage therapy significantly reduces pain, anxiety and muscle strain and provides relaxation and satisfaction (29,30,31).

Post-cesarean massage significantly reduces anxiety and pain. Massage is recommended to reduce pain and anxiety due to the simplicity, efficacy, reliability, low cost and lack of side effects of the application (32).

Massage was applied to the patients, who underwent abdominal colorectal surgery, on the postoperative 2nd and 3rd days and pain, tension, and anxiety changes before and after massage were observed. It has been proven that massage has a significant role in the postoperative recovery process of the patients undergoing colorectal surgery. It has been proven that post-mastectomy massage therapy is effective in reducing pain, anxiety, and tension and increasing relaxation (33).

Massage is included in the traditional treatment at various cancer treatment centers because it increases the levels of relaxation, sleep, immune system response quality, and reduces the fatigue, pain,

anxiety, and nausea levels of the patients. Massage is quite effective in reducing the surgery-related pain in patients with cancer. Foot reflexology massage is more effective than aromatherapy or body massage for reducing cancer pain (34,35).

Massage therapy can be a significant additional procedure that relieves pain in the recovery process after thoracic surgery. Despite improved efforts and innovations, most patients experience post-operative pain and discomfort. Massage therapy was applied to 160 patients, who were operated by general thoracic surgical methods including pulmonary resection, esophageal resection, and reconstruction due to benign and malign disease and through various pleural, chest wall, and mediastinal methods and had an average age of 60.7 of these women were female. Their pain levels before and after the massage were compared. It was found that there was a significant decrease in the pain level before and after the massage (36). In the present study, it was found that massage therapy can be performed safely in the hospital setting and can have significant clinical benefits.

In another study, 3-day kinesiologic taping before menstruation was applied to 20 out of 40 women suffering from primary dysmenorrhea; whereas, 20-minute connective tissue massage was applied to 20 women for 3 days before menstruation. At the end of the study, it was found that connective tissue massage and kinesiologic banding reduced the cramps in the lower abdominal region. Because the mechanical distortion induced by the connective tissue massage stretches helps to have the connective tissue mobilized. This leads to release histamine from the mast cells that cause local swelling and arteriolar dilatation. Thus, regional blood flow increases and inflammation decreases. Chemicals causing pain are removed from the tissue. Hence, inflammation and pain decrease (27).

Conclusion

In conclusion, the patients who decreased pain due to the connective tissue massage used less analgesic drugs, the patients in the experimental group experienced less nausea, vomiting, sleepiness and digestive and renal dysfunction problems. Due to all these reasons, the duration of discharge shortened in the patients having less complaints and the length of hospitalization decreased. It was thought that less use of analgesic drugs and decrease in the hospitalization time would decrease the cost rate.

Limitations

In our study, we examined the short-term changes of variables such as pain, quality of life, analgesic drug requirement and hospitalization period after thoracotomy, and the effects of connective tissue massage on these variables. But we did not examine the long-term consequences. In diseases such as cancer and osteoarthritis, massage should be applied for a long time. Osteoarthritis is a chronic condition and is different from the post-surgical period. For this reason, it is not necessary to apply long-term massage after surgery. However, the evaluation of the effectiveness of massage therapy after discharge may be the subject of further studies. Surgical incision often prevents patients from lying down and may require an alternative position. In our study, we applied connective tissue massage while the patients were sitting in a chair. The ideal application dose and duration of massage are not clear. Therefore, their effectiveness can be evaluated at different times and doses. In addition, the effects of connective tissue massage on respiratory functions were not evaluated objectively with spirometric measurements or blood gas results in our study. Future work can focus on this issue.

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Zeynep Berfu ECEMIS, PT, MSc[1]
Omer Burak TOR, PT, MSc[1]
Gamze COBANOGLU, PT, MSc[1]
Sinem SUNER-KEKLİK, PT,PhD,Assoc.Prof[2]
Nihan KAFA, PT, PhD, Assoc. Prof[1]
Nevin A. GUZEL, PT, PhD, Prof[1]

1 *Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara, Türkiye*
2 *Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Sivas, Türkiye*

Correspondence (İletişim):

Gamze COBANOGLU, PT, MSc
Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Besevler, Ankara, Türkiye
fztgamze7@gmail.com
ORCID: 0000-0003-0136-3607

Zeynep Berfu Ecemis
E-mail: zeynepartann@gmail.com
ORCID: 0000-0001-8136-8218

Omer Burak Tor
E-mail: omerburaktor@gmail.com
ORCID: 0000-0003-3060-2275

Sinem Suner-Keklik
E-mail: s-suner@hotmail.com
ORCID: 0000-0002-9506-3172

Nihan Kafa
E-mail: nkaratas@gazi.edu.tr
ORCID: 0000-0003-2878-4778

Nevin A. Guzel
E-mail: natalay@gazi.edu.tr
ORCID: 0000-0003-0467-7310

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WHOLE-BODY VIBRATION EFFECT ON MUSCLE ACTIVATIONS: WHICH ONE IS THE MOST EFFECTIVE, LOW FREQUENCY OR HIGH FREQUENCY?

ORIGINAL ARTICLE

ABSTRACT

Purpose: Whole Body Vibration (WBV) is a practice that passively applies mechanical oscillations to an individual from a support surface. The tonic vibration reflex response depends on the vibration localization, frequency, amplitude, and initial length of the muscle, but there is no consensus on what the optimal frequency should be. This study was conducted to examine the activation differences of lower extremity muscles at low and high frequencies during squat exercise on WBV.

Methods: This study involved 16 healthy individuals (Age = 23.66 ± 2.33 years, Body Mass Index = 22.59 ± 3.86 kg/m^2). WBV application was performed on a vertical vibration platform (GLOBUS Physioplate®). Participants performed static half-squats on WBV for 20 seconds under vibrating (20 Hz and 60 Hz; 2-3 mm amplitude) conditions. An 8-channel Electromyography (EMG) Noraxon MiniDTS system was used to measure the activation of the Gluteus Medius (GMed), Gluteus Maximus (GMax), Vastus Lateralis (VL), and Vastus Medialis (VM) muscles.

Results: It was observed that there was a difference between the two frequencies for the activation of the VM, VL, and GMed muscles (p = 0.004, 0.001, 0.002, respectively). Vibration frequencies of GMed, VL, and VM muscle activities at high frequency were increased compared to low frequency. GMax did not show any statistically significant change between the two vibration conditions (p=0.013).

Conclusions: Physiotherapists and trainers should prefer high frequencies in WBV applications, especially when they need to improve the neuromuscular response in the quadriceps and gluteus medius muscles.

Keywords: Electromyography, Frequency, Lower Extremity, Whole Body Vibration

TÜM VÜCUT VİBRASYONUN KAS AKTİVASYONLARINA ETKİSİ: HANGİSİ EN ETKİLİ, DÜŞÜK FREKANS MI YÜKSEK FREKANS MI?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Tüm Vücut Vibrasyon (TVV), kişiye bir destek yüzeyinden pasif olarak mekanik salınımlar uygular. Tonik vibrasyon refleksi yanıtı, vibrasyon lokalizasyonuna, frekansına, amplitüdüne ve kasın başlangıç uzunluğuna bağlıdır, ancak optimal frekansın ne olması gerektiği konusunda bir fikir birliği yoktur. Bu çalışma, TVV'de yapılan squat egzersizi sırasında alt ekstremite kaslarının düşük ve yüksek frekanslardaki aktivasyon farklılıklarını incelemek amacıyla yapılmıştır.

Yöntem: Bu çalışmaya 16 sağlıklı birey dahil edildi (Yaş = 23,66 ± 2,33 yıl, Vücut Kitle İndeksi = 22,59 ± 3,86 kg/m^2). TVV uygulaması, vertikal vibrasyon platformunda (GLOBUS Physioplate®) gerçekleştirildi. Katılımcılar düşük amplitüdte (2-3 mm) 20 Hz ve 60 Hz'lik vibrasyon durumlarında TVV üzerinde 20 saniye boyunca statik half-squat yaptılar. Gluteus Medius (GMed), Gluteus Maximus (GMax), Vastus Lateralis (VL) ve Vastus Medialis (VM) kaslarının aktivasyonunu ölçmek için 8 kanallı Elektromiyografi (EMG) Noraxon MiniDTS sistemi kullanıldı.

Sonuçlar: VM, VL, GMed kaslarının aktivasyonu için iki frekans arasında fark olduğu gözlendi (sırasıyla p = 0,004; 0,001; 0,002). Çalışmamız, yüksek frekanstaki GMed, VL ve VM kas aktivitelerinin titreşim frekanslarının düşük frekansa göre arttığını göstermektedir. Gmax kas aktivitesinde iki frekans arasında istatistiksel olarak anlamlı bir fark bulunmadı (p=0,013).

Tartışma: Fizyoterapistler ve antrenörler TVV uygulamalarında, özellikle quadriceps ve gluteus medius kaslarında nöromusküler yanıtı geliştirmeye ihtiyaç duyduklarında yüksek frekansları tercih etmelidirler.

Anahtar Kelimeler: Elektromyografi, Frekans, Alt Ekstremite, Tüm Vücut Vibrasyon

INTRODUCTION

Whole body vibration (WBV) is an exercise modality that can be used by applying indirect mechanical oscillations from the support surface to the target muscle (1). During the WBV exercise, the vibration is transmitted through the kinetic chain depending on the body position, and its energy is absorbed by the activated muscle (1,2). It has been shown that WBV exercises have a similar effect with strengthening and plyometric training on muscle activation, strength, and performance. For this reason, it has been applied to increase the effectiveness of the exercises in sports and rehabilitation programs and has become an important research topic in recent years (3,4).

The traditional theory explaining the possible mechanism of action of vibration stimulation is that as vibration produces rapid and short changes in the length of the muscular-tendon complex, it increases the activation of the terminations of the muscle spindle, creating a tonic vibration reflex (TVR) in the muscle (5). TVR results in increased muscle activation, contraction, and synchronization of the motor unit (6). TVR response depends on the localization of vibration, its frequency, amplitude, and the initial length of the muscle (5). Therefore, in studies with WBV, the effect of these parameters on the TVR response has commonly been investigated (3,5,6). Studies have shown that acute WBV generally provides higher EMG activation responses compared to no-vibration conditions (7-14). However, there are also studies that show the opposite results. Also, the effect of differences in vibration frequency on muscle activity is contradictory (15,16). Many studies include different exercise parameters (type of vibration platform, duration, and volume of exercises), vibration frequency, amplitude, and joint angles in order to evaluate the EMG activation of the lower extremities (7-16). Since various parameters are used in the studies and no consistent results are produced, the optimal vibration frequency remains uncertain (5). Thus, creating a WBV protocol for each type of exercise and target muscle would be a sensible approach.

The squat is a type of exercise that is commonly used in the strengthening and motor control exercises of the lower extremities and has become an essential part of hip and knee training programs (17). The primary muscle acting on the knee during squat exercise is the quadriceps femoris. Gluteus maximus (GMax) is a potent hip extensor and stabilizer, contracting eccentrically to inspect going down during squats and contracting concentrically to overcome external resistance when going up (18,19). Gluteus Medius (GMed) has a key role in providing pelvis and knee stabilization during the squat (20). There are many studies investigating the effect of vibration on the activity of the quadriceps muscles during squat exercise. However, there is no consensus in the related literature regarding the available information on the frequency at which the Vastus Medialis (VM) and Vastus Lateralis (VL) muscles are activated at a higher level during static half-squat exercises in the WBV application. Also, a limited number of studies were found for the GMax muscle, while no studies were found for the GMed muscle. Therefore, this study was conducted to investigate the effect of vibration frequency on lower extremity muscles (GMed, GMax, VL, VM) activations during static half-squat exercise.

METHODS

Participants

The study was approved by Gazi University Ethics Committee (Date: 14.07.2020, Number: 91610558-604.01.02, Research Code Number: 2020-374). After the participants were informed about the purpose and procedure of the study, an informed consent form was signed. Healthy volunteers between the ages of 18-30 were included in the study (Table 1). Individuals with any orthopaedics or neurological disorders that would affect their ability to exercise were not included. The study was completed with 16 individuals who agreed to participate in the study.

Experimental Design

The study design was determined as a single group and repeated measurement. The dependent variables were activation of lower extremity muscles (GMax, GMed, VM, and VL), while the independent variable was vibration frequency (20 Hz (low) and 60 Hz (high). In addition, evaluation was made in the static squat position in the vibration-free con-

dition. Moreover, one day was allocated to each subject in the experiments.

Procedures

Whole Body Vibration Protocol

A vertical vibration platform (GLOBUS Physioplate®) was used for WBV application. The subjects were asked to stand barefoot on the platform and maintain the static half-squat posture for 20 seconds under vibration-free and vibrating (20 Hz and 60 Hz; at 2-3 mm amplitude) conditions (9). The adverse effects of vibration on the human body occur below 20 Hz and above 60 Hz frequencies (3). For this reason, 20 Hz for low frequency and 60 Hz for high frequency were preferred. Simultaneous EMG measurement was performed to examine changes in muscle activation under different vibration conditions. Each of the three vibration conditions was performed twice. The subjects took a 2-minute rest between trials (21). The starting frequency for each participant was determined by randomization, and WBV frequencies were not told to the participants. Participants were asked to hold the handrail of the device and extend their arms straight. In addition, the participants were instructed to keep their trunk position upright, and their shanks were nearly vertical, preventing the knee joint from going over the toes. Using a universal goniometer, a physiotherapist measured the joint angle to keep 90° flexion angles (22) and ensured that the participants' body positions were maintained (23). This study preferred a 90° half-squat because the hip extensor torque peaks at 90° and angles above 90° are unreliable (19).

EMG Measurements

An 8-channel EMG Noraxon MiniDTS system (Noraxon, USA, Inc, Scottsdale, AZ) was used to assess the activation of the VM, VL, GMed, and GMax muscles. Unit specifications include a common-mode rejection ratio (CMRR) greater than 100dB and input impedance greater than 100 Mohm. The sampling rate for EMG data was 1500 Hz per channel. EMG measurement was performed with bipolar Ag/AgCl surface electrodes (Noraxon, USA, Inc, Scottsdale, AZ) with a center-to-center distance of 20 mm. Before placing electrodes to reduce skin impedance, the skin was cleaned with a 70% alcohol solution and body hair was removed (21). During all trials, the participants' EMG activity was recorded from their dominant leg. The surface electrodes were aligned in the direction of the muscle fibers (13). A clinical expert put the electrodes on the areas of interest, following the SENIAM project instructions (24). All electrodes were taped to the skin with double-sided tape to ensure that they stayed steady during the session, and the cables were taped to the skin with care.

The EMG signals were processed with MR 3.12 software (Noraxon, USA, Inc, Scottsdale, AZ) and then analyzed. For the data analysis, the middle 10 seconds of the test duration (from 5 seconds to 15 seconds) was chosen. First, the raw EMG signals were band-pass filtered (25) between 15 and 500 Hz. The raw EMG data were smoothed using a moving root-mean-square (RMS) filter (time window 100 ms) (26).

The baseline EMG activity was recorded at the beginning during static half-squat (knee flexion angle was 90°) without vibration (13). Then, the values were normalized to the muscle activities obtained during the no vibration according to the following formula:

vibration conditions/no vibration * 100.

Statistical Analysis

Statistical Package for Social Science (SPSS) version 23.0 (IBM Corp., Armonk, NY, 2015) was used for the statistical analysis. Descriptive analyses are presented as mean ± standard deviation. Bonferroni corrected Wilcoxon signed-rank test was used to examine the changes in muscle activities at different frequencies. The significance level was set at 0.0125. Post-hoc power analysis was conducted. The achieved power is 0.99 according to the G*Power analysis, the effect size of Cohen's d = 1.56 with alpha = 0.0125, and two-tailed (n = 16) in a Wilcoxon signed rank test (matched pairs).

RESULTS

Normalized mean values and standard deviations are shown for the no vibration condition. VM, VL, GMed muscle activities significantly increased under the high frequency vibration condition compared to low frequency (p = 0.004, 0.001, 0.002, respectively; Table 2 and Figure 1). GMax did not

Table 1. The Demographic Information of the Participants

	Participants (n=16) (Mean ± SD)
Age (years)	23.66 ± 2.33
Height (cm)	174.00 ± 12.00
Body weight (kg)	69.78 ± 28.85
Body Mass Index (kg/m^2)	22.59 ± 3.86

SD: Standard Deviation

Table 2. Neuromuscular Activity of the Muscles Between Low and High Vibration Frequencies (Normalized to the No Vibration Condition)

	Low Frequency (%) (Mean ± SD)	High Frequency (%) (Mean ± SD)	Changes in Muscle Activity (%) (Mean ± SD)	Z	p
VM	119.46 ± 19.02	142.42 ± 24.74	22.96 ± 24.42	**-2.844**	**0.004***
VL	112.12 ± 18.14	142.22 ± 22.86	30.10 ± 19.17	**-3.309**	**0.001***
GMed	143.69 ± 33.00	189.84 ± 38.68	46.15 ± 42.22	**-3.103**	**0.002***
GMax	152.45 ± 30.80	194.52 ± 52.04	42.06 ± 56.93	**-2.482**	**0.013**

VM: Vastus Medialis, VL: Vastus Lateralis, GMed: Gluteus Medius, GMax: Gluteus Maximus, SD: standard deviation, *p<0.0125

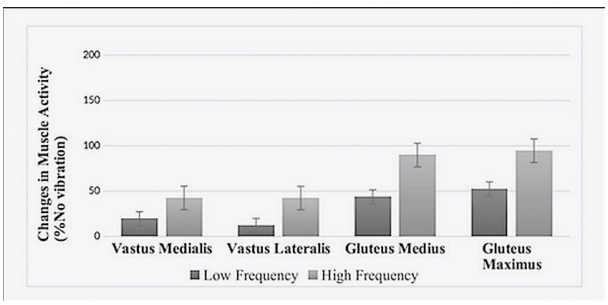

Figure 1. The mean and standard errors of normalized values to the no vibration condition neuromuscular activity in knee and hip muscles during Whole Body Vibration in response to the low and high frequencies.

show any statistically significant change between the two vibration conditions (p=0.013).

DISCUSSION

This study investigated the effect of static half-squat exercise performed at low (20 Hz) and high (60 Hz) frequencies in WBV on EMG activity of the lower limb muscles. It was found that high vibration frequency was more effective on muscle activation responses than low frequency in VM, VL, and GMed. There was no statistically significant change in GMax muscles.

The effects of different vibration frequencies applied during various exercises on muscle activities have often been investigated (8,10,11,14). Most of the studies have shown that adding vibration to exercise increases the EMG activities of the VM and VL muscles (11,12,14). In our study, increasing the vibration frequency led to an improved EMG activity of the VM and VL muscles. There are studies that support our findings (10,11,21). Krol et al. investigated the effects of amplitude (2-4 mm) and frequency (20, 40, and 60 Hz) on VL and VM activity in female participants only. It was determined that the highest muscle activation was seen when the frequency and amplitude were set at 60 Hz and 4 mm, respectively (21). Perchthaler et al. also recorded EMG signals of VL and VM muscles during the squat with different knee flexion angles at 6, 12, 18, 24, and 30 Hz frequencies. They similarly demonstrated that an optimal WBV protocol is achieved with higher frequency (10). These results indicated that even low level of changes in vibration frequency causes a significant increase in the muscle activity. The vibration increases the activation of the muscle spindle and creates a TVR in the muscle (27). This response is more elicited at higher vibration frequencies, resulting in an increased EMG activity (28). The WBV with high frequencies also contributes to a large number of simultaneously stimulated motor units and this results in a

higher muscle activation (18,24). Although most of the studies showed significant improvement in the muscle activities by increasing the frequency, some studies have controversial results. Cardinale and Lim (2003) investigated different frequencies (30, 40 and 50 Hz.) during isometric half-squat exercise in professional women volleyball players. The higher muscle activity was shown during the lowest vibration frequency (7). Borges et al. (2017) compared VL muscle activity during half-squat exercise under no vibration and two different vibration conditions (30 and 50 Hz.) in 40 healthy women (29). Their results showed that muscle activity increased in vibration conditions but there were no significant differences between the two vibration conditions. The reason for these inconsistent results in the literature may be the highly variable demographics of population and vibration parameters (frequency, amplitude, duration). Due to the variety of parameters, it is very difficult to determine the optimal frequency for each muscle. Therefore, related studies should be specific to each muscle, exercise, and population.

Although there are many studies in the literature assessed the response of the quadriceps muscle activity to WBV during the squat, there are limited studies investigating the gluteal muscles (22,30-33). In our study, GMax muscle activity was not affected by the changes of frequency. Zaidell et al. (31) evaluated the effect of 20, 25, and 30 Hz vibration frequencies on GMax EMG activity during the squat (30°) and standing position. Muscle activity during the squat increased with WBV compared to the no-vibration condition. However, similar to our results, vibration frequency did not affect GMax muscle activity. The vibration energy produced by the WBV device decreased while transmitting through the body. Vibration energy is damped by muscles and joints as it is transmitting through the body (22,31). For this reason, it is thought that the muscles closer to WBV platform may show higher activation than the muscles far from the platform. Zaidell et al. (31) stated that higher frequencies or deeper squat angles may be effective in inducing the activity of the GMax muscle located distal to the platform. In our study, higher frequency (60 Hz) and deeper squat angle (90 degrees) were used. However, there was no significant difference between the low and high frequency of vibration in GMax activity. It has been reported that increasing the knee angle (>30degree) during the squat decreases the vibration energy transmitted to the proximal body part (hip and head region) as the knee muscles may absorb more energy. This may explain the results showing a statistically significant difference between high and low frequencies (27). In addition, the duration of exposure to vibration may affect the activation response. Longer exposure to vibration may be required to elicit the tonic vibration reflex in the GMax muscle (1). Pollock and colleagues recorded EMG signals of GMax muscle during 15° knee flexion at different low frequencies (5, 10, 15, 20, 25, and 30). Similar to our results, they found that GMax muscle activation did not change with frequency. The reason for this result may be the preferred vibration frequencies that are very close to each other (30). Liu et al. (32) investigated the effect of body positions during different squat tasks (static, static with elastic band loading, and dynamic squat) and amplitude of the vibration on muscular activity in GMax in middle aged and older women. They showed that there were no differences between vibration and no vibration conditions during static squat in GMax muscles. WBV does not affect gluteus maximus activity in different squat tasks. On the contrary, Duck et al. (22) showed that high frequencies (50 and 60 Hz) result in higher EMG responses in GMax than low frequencies (20 Hz). Kim and Seo investigated the change of GMax muscle activation with different vibration frequencies (0, 10, 20 Hz) and different pelvic positions (neutral, anterior, and posterior pelvic tilt) when standing still. The results showed that higher frequencies (20 Hz) and the use of posterior pelvic tilt during WBV improved GMax activation (33).

Although there are studies evaluating VM, VL, and GMax muscle activities during squat exercises with different knee angles and vibration parameters, no study has been found on the GMed muscle activity during squat exercises with vibration condition. Only the study by Aguilera-Castells et al. assessed the response of the GMed muscle to vibration of 30 and 40 Hz during the suspended lunge and Bulgarian squat exercises (34). Their results demonstrated that there was a statistical difference between no vibration and vibration conditions but no statisti-

cally significant difference between the two vibration frequencies. However, our study showed that increased vibration frequency improved neuromuscular responses in GMed. Differences in the activation responses of the Gmed muscle were observed in the two studies. There may be many reasons for this difference (population selection, exercise type, amount of vibration and amplitude). In our study, two vibration frequencies (vibration 20 or 60 Hz and 2 mm of amplitude) are compared during squat exercise in a mixed group of men and women. However, in the study of Aguielera Castells et al., 2 different vibration frequencies were applied (vibration 30 or 40 Hz and 4 mm of amplitude) during bulgarian squat and suspended lunge exercises only to men. There might not have been a difference in the activation response of the Gmed muscle due to the fact that they chose 2 frequencies very close to each other in their studies. In addition, the exercises used in the studies differ from each other. Since each muscle's contribution rate and response to each exercise are different, it might have given different responses to different frequencies. In addition, the difference in the selected population and amplitude in both studies might have affected the results. The gluteal muscles have a key role in improving athletic performance, preventing and rehabilitating lower extremity injuries (35). For this reason, determining the optimal WBV frequency for the gluteal muscles is important for the correct training of these muscles. More studies are needed to assess the gluteal muscle activities with WBV.

In raw EMG data, sharp peaks of the power spectrum are observed during WBV exercises. Some authors point out that accurate EMG measurement is difficult to obtain due to motion artifacts occurring during WBV exercises and the exact activation level cannot be determined. For this reason, notch filter of vibration frequency and its harmonics is used in some studies (29). As the neuromuscular response to vibration frequency has been shown to contribute more than motion artifacts, no additional filter is suggested (36,37).

The vibration stimulus in the WBV device used in the study was applied only vertically up and down with 2–3 mm amplitude, excluding other oscillations and amplitudes. In addition, the effect of multiple WBV sessions was not examined in this study. Our research was completed with one-time evaluation results. The fact that the long-term training effect was not evaluated is a limitation of this study. WBV studies should be performed in different populations and with more participants and, if possible, with long-term interventions.

As a result of this study, the effect of high vibration frequency on VM, VL, and Gmed muscles was found to be higher compared to low vibration frequency. It has been determined that 60 Hz frequency is more appropriate to maximize VM, VL, and Gmed muscle activation responses in WBV application. Physiotherapists who incorporate WBV into their programs in training lower extremity rehabilitation can optimize their training programs. Moreover, EMG recordings can be a tool to individualize training protocols for WBV. In this way, maximal neuromuscular development can be achieved by determining the optimal frequency specific to the individual.

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Conflict of Interest: The authors report no conflict of interest.

Ethical Approval: The study was approved by Gazi University Ethics Committee (Date: 14.07.2020, Number: 91610558-604.01.02, Research Code Number: 2020-374).

Author Contributions: ZBE: Collection of data, interpretation of data, drafted manuscript, literature review; OBT: Collection of data, analysis and interpretation of data; GC: Collection of data, interpretation of data, drafted manuscript; SSK: Study design, critical revision of manuscript; NK: Study design, critical revision of manuscript; NAG: Study design, critical revision of manuscript.

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Gamze Nalan ÇİNAR, PT[1]
Türkan AKBAYRAK, PT[1]
Gülbala GÜLÖREN, PT[1]
Serap ÖZGÜL, PT[1]
Esra ÜZELPASACI, PT[2]
Emine BARAN, PT[3]
Ceren GÜRŞEN, PT[1]
Kemal Beksaç, MD[4]
Emine Aydın, MD[5]
Gökçen ÖRGÜL, MD[6]
Mehmet Sinan BEKSAÇ, MD[5]

1 *Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, Ankara, Türkiye*
2 *University of of Health Sciences, Gulhane Faculty of Health Sciences, Ankara, Türkiye*
3 *Hitit University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Çorum, Türkiye*
4 *Ankara Oncology Hospital, Department of General Surgery, Ankara, Türkiye*
5 *Hacettepe University, Department of Obstetrics and Gynecology, Division of Perinatology, Ankara, Türkiye*
6 *Selçuk University, Department of Obstetrics and Gynecology, Division of Perinatology, Konya, Türkiye*

Correspondence (İletişim):

Gamze Nalan ÇİNAR, PT
Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, 06100, Samanpazari, Ankara, Türkiye.
E-mail: nalan.gd@gmail.com
ORCID: 0000-0001-8700-2153

Türkan AKBAYRAK, PT
E-mail: takbayrak@yahoo.com
ORCID: 0000-0001-5840-5252
Gülbala GÜLÖREN, PT
E-mail: gulbala_n@hotmail.com
ORCID: 0000-0001-5331-786X
Serap ÖZGÜL, PT
E-mail: serapky@yahoo.com
ORCID: 0000-0002-2362-6773
Esra ÜZELPASACI, PT
E-mail: uzelpasaciesra@gmail.com
ORCID: 0000-0002-0960-122X
Emine BARAN, PT
E-mail: eminekbaran@gmail.com
ORCID: 0000-0003-4974-6543
Ceren GÜRŞEN, PT
E-mail: cerengursen@yahoo.com
ORCID: 0000-0002-9204-8364
Kemal Beksaç, MD
E-mail: kemalbeksac@yahoo.com
ORCID: 0000-0002-6339-505X
Emine Aydın, MD
E-mail: eminebaskurtaydin@gmail.com
ORCID: 0000-0001-8877-2803
Gökçen ÖRGÜL, MD
E mail: gokcenorgul@gmail.com
ORCID: 0000-0003-0578-4230
Mehmet Sinan BEKSAÇ, MD
E-mail: beksacsinan@gmail.com
ORCID: 0000-0001-6362-787X

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CORRELATION BETWEEN VARIOUS ANTHROPOMETRIC AND MUSCULOSKELETAL MEASUREMENTS AND HEMORRHOIDS IN PREGNANCY

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study was to determine the presence of hemorrhoids in pregnancy and symptoms related to hemorrhoids and to evaluate the relationship between hemorrhoids in pregnancy and various anthropometric and musculoskeletal parameters.

Methods: The retrospective cross-sectional study included pregnant women in 3 different trimesters (1st, 11-15 weeks; 2nd, 16-23 weeks; 3rd, 24-40 weeks) without any anorectal problems before pregnancy. The presence of hemorrhoids and other anorectal symptoms during pregnancy was evaluated with yes/no questions on self-reported scales.

Results: Evaluation was made of 268 pregnant women (92, 1st Trimester; 107, 2nd Trimester; 69, 3rd trimester). In the whole study sample, waist circumference measurement (p = 0.042; OR = 1.13; 95% CI 1.07–1.92), bi-iliac width (p = 0.036; OR = 1.17; 95% CI 1.09–1.38), rectus abdominis muscle strength (p = 0.006; OR = 0.45; 95% CI 0.04–0.58), Diastasis-recti-abdominis grade measured from umbilicus level (p = 0.023; OR = 1.38; 95% CI 1.14–1.83), hypermobility score (p = 0.006; OR = 3.34; 95% CI 1.98–7.94) and parity (p = 0.032; OR = 2.47; 95% CI 1.85–7.19) were found to be important risk factors for the presence of hemorrhoids in pregnancy.

Conclusion: This is the first study to have evaluated hemorrhoids and hemorrhoid-related symptoms and to examine the associated risk factors comprehensively. It was also demonstrated for the first time that waist circumference measurement, bi-iliac width, increased grade of Diastasis-recti-abdominis measured at umbilicus level, hypermobility score, and decreased rectus abdominis muscle strength were risk factors for hemorrhoids in pregnancy.

Keywords: Anthropometric Measurements, Hemorrhoids, Pregnancy.

GEBELİKTE GÖRÜLEN HEMOROİD İLE ANTROPOMETRİK ÖLÇÜMLER VE KAS-İSKELET SİSTEMİ ÖLÇÜMLERİ ARASINDAKİ İLİŞKİNİN İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı, gebelikte hemoroid varlığı ve hemoroid ile ilgili semptomları incelemek ve gebelikte hemoroid varlığı ile çeşitli antropometrik ve muskuloskeletal parametreler arasındaki ilişkiyi araştırmaktı.

Metod: Bu retrospektif kesitsel çalışmaya gebelik öncesi herhangi bir anorektal problemi olmayan, 3 farklı trimesterdaki (1. Trimester, 11-15 hafta, 2. Trimester, 16-23 hafta, 3. Trimester, 24-40 hafta) gebeler dahil edildi. Gebelikte hemoroid ve diğer anorektal semptomların varlığı self-reported olarak var/yok şeklinde değerlendirildi.

Bulgular: Çalışmaya 268 gebe (92, 1. trimester; 107, 2. trimester; 69, 3. trimester). Tüm çalışma örnekleminde bel çevre ölçümü (p= 0,042; OR = 1,13; % 95 CI 1,07–1,92), bi-iliak genişlik (p= 0,036; OR = 1,17; % 95 CI 1,09–1,38), rectus abdominis kas kuvveti (p= 0,006; OR = 0,45; % 95 CI 0,04–0,58), umbilikus seviyesinden ölçülen diastazis rekti abdominis (DRA) miktarı (p= 0,023; OR = 1,38; % 95 CI 1,14–1,83), hipermobilite skoru (p= 0,006; OR = 3,34; % 95 CI 1.98–7,94) ve doğum sayısı (p= 0,032; OR = 2,47; % 95 CI 1,85–7,19) hemoroid gelişiminde önemli risk faktörleri olarak bulundu.

Sonuç: Bu çalışma, hemoroid ve hemoroid ile ilişkili semptomları değerlendiren ve hemoroid ile ilişkili risk faktörlerini uygun örneklem genişliği ile kapsamlı olarak değerlendiren tek çalışmadır. Aynı zamanda gebelikte, bel çevre ölçümünün, bi-iliak genişliğin, umblikus seviyesinden ölçülen DRA miktarının ve hipermobilite skorunun artmasının ve rektus abdominis kas kuvvetinin azalmasının hemoroid açısından risk faktörü olduğu ilk kez bu çalışma ile ortaya konulmuştur.

Anahtar Kelimeler: Antropometrik Ölçümler, Gebelik, Hemoroid

INTRODUCTION

Hemorrhoids which develops with the prolapse of the distal rectum contains rectal mucosa, smooth muscle, connective tissue, and blood vessels are common anal canal problem with high recurrence rates and accompanied by acute attacks and chronic symptoms. The incidence of hemorrhoids increases during the reproductive years, especially in pregnancy (1). The incidence has been reported at approximately 85%, especially in the 2nd and 3rd trimesters of pregnancy (2).

Hemorrhoids are classified into three categories: internal (above the dentate line), external (below the dentate line), and mixed. Pregnancy increases the formation of venous veins, the incidence of venous problems, and the incidence of symptomatic hemorrhoids (3). The factors that cause this condition are explained mechanically (expanding uterus, with increasing fetus weight causes venous obstruction in the internal sphincter and enlargement and sagging of the hemorrhoidal plexus) and hormonally (decrease in the level of estradiol and progesterone and decreased gastrointestinal motility) (1).

While pregnancy itself is mentioned as a risk factor for hemorrhoids formation, there are many factors that increase the risk of hemorrhoids during pregnancy (4). In previous studies, it has been stated that obesity, high depression levels, low quality of life, eating disorders, and high doses of iron supplements also increase the risk of hemorrhoids (5). Although there is no research on the topic examining the connection between hemorrhoids and hypermobility in pregnancy, it was stated in a study of Ehlers-Danlos Syndrome that hypermobility associated with connective tissue problems was associated with hemorrhoids. However, that and similar studies in the literature were not conducted on pregnant women (6). Although there are studies in the literature which have investigated the risk factors affecting the formation of hemorrhoids in pregnancy, there are no studies which have examined the relationship between the presence of hemorrhoids and various anthropometric and musculoskeletal parameters. Therefore, this study was planned to investigate the presence of hemorrhoids in pregnancy and symptoms related to hemorrhoids and to evaluate the relationship between hemorrhoids in pregnancy and various anthropometric and musculoskeletal parameters.

MATERIAL AND METHODS

2.1. Study design and participants

This retrospective cross-sectional study was carried out between January 2016 and May 2018 at Hacettepe University, Faculty of Medicine, Department of Obstetrics and Gynecology. The study included pregnant women aged >18 years, who were literate and had no anorectal problems before pregnancy and were in 3 different trimesters (1st Trimester, 11-15 weeks, 2nd Trimester, 16-23 weeks, 3rd Trimester, 24-40 weeks). High-risk pregnant women with gastrointestinal disease, a history of pelvic or anal surgery, hypertension, and/or diabetes mellitus were excluded from the study. All pregnant women were informed about the study on the basis of the Helsinki Declaration and informed consent was obtained for participation in the study. Approval for the study was granted by the Local Ethics Committee of the university (decision no: GO 16/101-30).

2.2. Evaluations

Sociodemographic and Clinical Evaluation

The socio-demographic information, physical characteristics, and detailed obstetric anamnesis (gravida, parity, abortion, curettage) of the pregnant women included in the study were recorded.

Pregnant women participating in the study were evaluated as present/absent according to the presence of hemorrhoids. A valid and reliable classification system was used to define the severity of hemorrhoids: Stage 1 = internal hemorrhoids that do not prolapse, Stage 2 = internal hemorrhoids that prolapse during defecation but decrease spontaneously, Stage 3 = internal hemorrhoids that prolapse and require manual repulsion during defecation, Stage 4 = internal hemorrhoids that prolapse and cannot be manually pushed (7). The presence of constipation, perianal discomfort and pain, protrusion, bleeding, mucous discharge, pruritus, and burning were evaluated as present/absent. Fecal type was determined according to the Bristol Gai-

ta Scale (BGS) (Type 1-2 hard, Type 3-4-5 normal, Type 6-7 diarrhea) (intra and inter-observer ICC values of 0.88 and 0.89, respectively) (8). The colorectoanal problems of the pregnant women and the degree of complaints were evaluated according to the subscales of the Pelvic Floor Distress Inventory-20 Scale of the Pelvic Floor Distress Inventory-20 (KRADE-8), as described by Barber et al. (9) and 2010 Toprak et al (2010) (10), the Turkish version of which have been reported as valid ($p < 0.001$) and reliable (Cronbach's alpha, 0.79, ICC, 0.96-0.98). The scale consists of eight items with a total score ranging from 0 to 100. More severe symptoms are indicated by a higher score.

Anthropometric Measurements

- Circumference measurements: Waist circumference, umbilicus circumference, and hip circumference were evaluated. With the arms out to the side, the narrowest part of the waist between the iliac crests and the subcostal region was measured. The hip circumference was measured from the most prominent portion of the gluteal region at the back while holding the tape measure parallel to the hip (11).

- Diameter measurements: The bi-iliac width (pelvis width) was measured by placing the caliper at an angle of 45° downward on the iliac crests. Bi-trochanteric width was measured from the widest distance between the trochanter bones (12).

Measurement of Abdominal Muscle Strength

Lovett's manual muscle test method (intra and inter-observer ICC values of 0.8 and 0.96, respectively) was used to measure the strength of the rectus abdominis and external oblique muscles (right and left) with a grading system between 0-5. In the muscle test, level 3 was taken as a reference and individuals were grouped as ≤3 and below and >3 according to their muscle strength (13).

Musculoskeletal Measurements

-Lumbal lordosis: Each pregnant woman was asked to stand in a comfortable posture with their feet shoulder-width apart and their arms held loosely next to the trunk. A bubble inclinometer (Model 10602, Fabrication Enterprise Inc.,USA), which has been shown to be a valid and reliable device for lumbal lordosis evaluation (intra and inter-observer ICC values 0.85 and 0.9, respectively) (14) was used at the level of T12-L1 and S1-S2. The inclinometer was placed at the marked points as described by Kolber and Salamh and 3 measurements were taken from each point and the average of the recorded angle values was recorded (15).

-Diastasis recti abdominis (DRA): DRA was evaluated with the method of finger and width (intra and inter-observer ICC values of 0.7 and 0.5, respectively) while the pregnant women were in the supine and hook position. The measurement was performed in three places, from the level of the umbilicus, and at 4.5 cm above and below the umbilicus (16).

-Joint hypermobility: The joint hypermobility of the cases was evaluated using the Beighton scoring method (intra and inter-observer ICC values of 0.4 and 0.8, respectively). Touching the floor with the palmar face of the hand when the knees are in full extension (1 point), hyperextension of ≥10° of the elbow (2 points), knee hyperextension of ≥10° (2 points), passive positioning parallel to the forearm flexor face of the thumb (2 points) and 5th metacarpal joint ≥90° passive extension (2 points). A score of ≥4 points was considered hypermobility (17).

Sample Size Calculation

A binary logistic regression analysis model was used to calculate the risk factor effects. There were a total of 11 risk factors in the model. It has been suggested in the literature that at least 20 people should be included for each risk factor in the regression model (18). Therefore, when 11 risk factors were calculated, it was deemed necessary to include at least a total of 220 people should be present.

2.3. Data Analysis

Data obtained in the study were analyzed statistically using SPSS 23 software (Statistical Package for Social Sciences for Mac version 20.0- Chicago, USA). Descriptive statistics of the data were calculated. In comparing anthropometric parameters according to the presence of hemorrhoids, the Chi-square test was applied to categorical variables, the Student's t-test for normally distributed numerical variables, and the Mann-Whitney U-test for

numerical data that do not show normal distribution. A value of p<0.05 was considered statistically significant. According to the univariate analysis, variables with p<0.20 were considered significant and were included in the binary logistic regression model. Abdominal muscle strength measurement results were categorized into two categories so that multi-category ordinal variables could be included in the model. A value of p<0.05 was considered statistically significant.

RESULTS

A total of 297 pregnant women were initially screened of which 29 were excluded for various reasons; history of the anorectal disease (n=11), perianal surgery (n=3), hypertension (n=6), multiple pregnancy (n=4), gestational diabetes (n=5). Consequently, evaluation was made of 268 pregnant (1st trimester=92, 2nd trimester=107, and 3rd trimester=69). The sociodemographic and clinical characteristics, and detailed obstetric histories

Table 1. Sociodemographic, Clinical and Obstetric Characteristics and Medical Characteristics of the Pregnant Women Between Study Groups

		All Pregnancy (n:268)	Hemorrhoid (No) (n:184)	Hemorrhoid (Yes) (n:84)
Age (year)		31.19±3.95	31.25±4.12	31.05±4.13
Height (cm)		162.48±4.85	162.37±4.85	162.71±4.86
Current body weight (kg)		69.51±10.03	70.08±10.74	68.23±8.18
BMI (kg/m^2)		26.28±3.69	26.54±3.90	25.72±3.12
Body weight before pregnancy (kg)		63.16±10.45	63.82±10.83	61.72±9.49
BMI before pregnancy (kg/m^2)		23.93±3.93	24.21±4.09	23.31±3.47
Fetus weight (kg)		964.86±814.18	876.29±688.48	1202.90±1059.21
Gravida		3.20 (1.00-15.00)	3.37 (1.00-15.00)	2.83 (1.00-8.00)
Parity		0.70 (0-4.00)	0.71 (0-4.00)	0.66 (0.00-3.0)
Nullipar (%)		130 (48.50)	94 (51.08)	36 (42.85)
Primipar (%)		102 (38.05)	61 (33.15)	41 (48.80)
Multipar (%)		36 (13.43)	29 (15.76)	7 (8.33)
Abortion-Curettage		1.00 (0-10.00)	1.00 (0-10.00)	1.00 (0-5.00)
The severity of hemorrhoids (%)	**Stage 1**	39 (46.42)	-	39 (46.42)
	Stage 2	36 (42.85)	-	36 (42.85)
	Stage 3	7 (8.33)	-	7 (8.33)
	Stage 4	2 (2.38)	-	2 (2.38)
Ano-rectal symptoms in pregnancy(%)	**Perianal discomfort**	23 (8.58)	9 (4.89)	14 (16.66)
	Mucous discharge	57 (21.26)	19 (10.32)	38 (45.23)
	Pruritus	28 (10.44)	13 (7.06)	15 (17.85)
	Burning	19 (7.08)	9 (4.89)	10 (11.90)
	Perianal pain	30 (11.19)	8 (4.34)	22 (26.19)
	Protrusion	26 (9.70)	2 (1.08)	24 (28.57)
	bleeding	18 (6.71)	3 (1.63)	15 (17.85)
	Constipation	57 (21.26)	23 (12.50)	34 (40.47)
KRADE-8		9.47±13.00	8.94±12.63	10.61±13.78
Fecal type	**Hard**	33 (12.31)	23 (12.50)	10 (11.90)
	Normal	164 (61.19)	116 (63.04)	48 (57.14)
	Diarrhea	71 (26.49)	45 (24.45)	26 (30.95)

*Data are presented as mean ± standard deviation, median (minimum-maximum), or frequency (%), BMI: Body Mass Index

Table 2. Anthropometric and Musculoskeletal Characteristics of the Pregnant Women Between Study Grpups

		All Pregnancy (n:268)	Hemorrhoid (No) (n:184)	Hemorrhoid (Yes) (n:84)	p
Lumbal lordosis (°)		91.58±14.10	90.89±13.47	93.08±15.38	0.963
Waist circumference (cm)		83.00±9.36	83.76±9.85	81.35±8.00	**0.043**
Umbilicus circumference (cm)		96.44±10.52	96.71±11.12	95.86±9.12	0.127
Hip circumference (cm)		102.26±7.65	102.70±8.23	101.29±6.13	0.241
Strength of the rectus abdominis		4.30±0.89	4.37±0.87	4.15±0.92	**0.013**
Strength of the right external oblique		4.17±0.91	4.27±0.89	3.95±0.91	**0.024**
Strength of the left external oblique		4.17±0.90	4.27±0.89	3.96±0.91	**0.030**
Bi-iliac width (cm)		29.10±5.91	29.45±6.29	28.28±4.88	0.167
Bi-trochanteric width (cm)		32.09±6.47	32.26±6.96	31.70±5.18	0.173
Diastasis recti abdominis (finger)	Umbilicus	1.77 (0-4.00)	1.69 (0-4.00)	1.94 (0-4.00)	**0.003**
	4.5 cm above	1.08 (0-3.00)	1.03 (0-3.0)0	1.19 (0-3.00)	**0.027**
	4.5 cm below	0.54 (0-3.00)	0.59 (0-3.00)	0.52 (0-3.00)	0.132
Joint hypermobility Yes (%)		66 (24.62)	43 (23.36)	23 (27.38)	0.480
Joint hypermobility score		4.72±0.89	4.51±0.75	5.13±1.01	0.167

Data are presented as mean ± standard deviation, median (minimum-maximum), or frequency (%).

such as gravida, parity, abortus, and curettage for all the subjects are given in Table 1.

The presence of hemorrhoids during pregnancy was determined at the rate of 31.34% (grade 1, 46.42%; grade 2, 42.85%; grade 3, 8.33%, and grade 4, 2.38%) in the whole study sample. The incidence of all anorectal problems, KRADE-8 scores were higher than in those without hemorrhoids. According to the BGS, of the whole sample of pregnant women, 61.19% had normal type faeces, 26.49% had diarrhea, 12.31% had hard type faeces, and 21.26% had constipation in all pregnant women. The rate of constipation was 40.47% in pregnant women with hemorrhoids and 12.50% in pregnant women without hemorrhoids. Detailed medical informations of all the pregnant women are given in Table 1.

When the anthropometric and musculoskeletal measurement results of the pregnant women participating in the study were examined, it was seen that the lumbal lordosis values of the whole study sample were 91.50 ± 14.10 and there was no difference according to the presence of hemorrhoids (p>0.05). A significant difference was determined between the groups in respect of waist circumference measurements (p= 0.043), and there was no difference between the groups in respect of umbilicus and hip circumference measurements (p>0.05). There was a difference between the groups in respect of the strength values of the rectus abdominis (p=0.013) and external oblique muscles (right: p=0.024, left: p=0.030). When the bi-trochanteric and bi-iliac diameter measurement results were examined, there was no difference between the groups (p> 0.05). The DRA grades measured at the umbilicus level and at 4.5 cm above and below were 1.77 (0-4.00), 1.08 (0-3.00), and 0.54 (0-3.00), respectively. According to the presence of hemorrhoids, there was a difference in the DRA grades measured at the umbilicus and at 4.5 cm above the umbilicus (p = 0.003, 0.027), and no difference between the groups in the DRA grade measured at 4.5 cm below the umbilicus (p> 0.05). The Beighton hypermobility score of the whole study sample was 4.72 ± 0.89, and benign joint hypermobility was observed in 24.62% of the pregnant women. There was no significant difference determined between the groups (p> 0.05). The anthropometric and musculoskeletal measurements of all the women are presented in Table 2.

Risk factors associated with anthropometric and

Table 3. Analysis of Potential Risk Factors for Hemorrhoids During Pregnancy CI: Confidence Interval, p<0.05.

	All Pregnancy		
	Odds ratio	**95% CI**	**p**
Waist circumference	1.13	1.07-1.92	**0.042**
Bi-iliac width	1.17	1.09-1.38	**0.036**
Bi-trochanteric width	1.09	0.95-1.25	0.215
Strength of the rectus abdominis	0.45	0.04-0.58	**0.006**
Diastasis recti abdominis -Umblicus	1.38	1.14-1.83	**0.023**
Joint hypermobility score	3.34	1.98-7.94	**0.006**
Parity	2.47	1.85-7.19	**0.032**

musculoskeletal measurements in hemorrhoids

As a result of anthropometric and musculoskeletal measurements and obstetric evaluations among the groups separated according to the presence of hemorrhoids during pregnancy; variables with a p value <0.20 (waist circumference, rectus abdominis muscle strength, bi-iliac and bi-trochanteric width, DRA grade of umbilicus level and hypermobility score) were added to the binary logistic regression analysis. The risk model including these parameters and corrected effects is shown in Table 3.

Associated factors were not included in the regression model. Thus, only one of the circumference, muscle strength, and DRA measurement results were added to the model.

The binary logistic regression analysis, it was determined that 6 risk factors were significantly associated with the development of hemorrhoids in pregnant women: waist circumference, bi-iliac width, rectus abdominis muscle strength (≤3), DRA measured from umbilicus level, and parity. The increase in hemorrhoid incidence was determined as 1.13-fold (OR) with increased waist circumference (p=0.042; 95% CI 1.07–1.92), 1.17-fold with large bi-iliac width, (p=0.036; 95% CI 1.09–1.38), 0.45-fold with rectus abdominis muscle weakness (p=0.006; 95% CI 0.04–0.58), 1.38-fold with increased DRA measured from the umbilicus level (p=0.023; 95% CI 1.14–1.83), 3.34-fold with increased hypermobility score (p=0.006; 95% CI 1.98–7.94), and 2.47-fold with high parity (p=0.032; 95% CI 1.85–7.19). The parameter of lordosis was not determined as a risk factor affecting the development of hemorrhoids.

DISCUSSION

The aim of this study was to determine the incidence of hemorrhoids and symptoms related to hemorrhoids in pregnancy, and to evaluate the relationship between various anthropometric and musculoskeletal parameters in pregnancy. Evaluation was made of a total of 268 pregnant women from all 3 trimesters, separated into two groups according to the presence of hemorrhoids. To determine the anthropometric and musculoskeletal parameters associated with hemorrhoids, evaluations were made of lordosis, waist, umblicus and hip circumference, rectus, right and left external oblique abdominal muscle strenght, bi-iliac and bi-trochanteric width, DRA grade measured at umbilicus level and 4.5 cm above and below, and hypermobility. Previous studies of hemorrhoids during pregnancy have mostly been conducted during the third trimester and postpartum (4), immediately after birth (19) or 6 weeks after birth (20). To the best of our knowledge, there is no information in literature of the relationship between hemorrhoids and anthropometric and musculoskeletal parameters. Therefore, the results of this study can be considered important in filling this gap in literature with the determination of symptoms related to hemorrhoids and the relationship between hemorrhoids and various anthropometric and musculoskeletal parameters in pregnant women.

It was determined from the study results that waist circumference measurement and bi-iliac width, decreased rectus abdominis muscle strength, DRA grade measured at the umbilicus level, and the hypermobility score were high risk factors for the development of hemorrhoids during pregnancy.

Although the incidence of hemorrhoids is very common during pregnancy, especially in the 2nd and 3rd trimesters, the primary cause is not fully known (1). With the growth of the uterus in the third trimester of pregnancy in particular, the incidence of hemorrhoids and anorectal symptoms increases with compression of the intestinal tract and lower part of the rectum (21). In few published clinical studies, the frequency of symptomatic hemorrhoids in pregnancy has been reported to vary between 7.9% and 38% (1, 4). In the results of the current study, hemorrhoids were seen to develop during pregnancy at the rate of 31.34% in women who had not had any perianal problems before pregnancy.

The clinical symptoms and signs of hemorrhoids during pregnancy include anal bleeding, anal itching, pain, and impaired bowel function, which worsen with increased intra-abdominal pressure such as sneezing and coughing (1). Abramowitz et al. reported that 9.1% of pregnant women experienced peri-anal discomfort (4). Poskus et al. stated the incidence of hemorrhoids-related anorectal disorders during pregnancy to be 1.6% in the 1st trimester and 61% in the 3rd trimester (22). In the current study, it was determined that the women with hemorrhoids during pregnancy had more anorectal problems than those without hemorrhoids, with higher KRADE-8 scores indicating worse symptoms associated with hemorrhoids.

Functional constipation during pregnancy has been reported to be a risk factor for hemorrhoid development with incidence of approximately 38% (4, 21). Abramowitz et al. reported that constipation is an important factor for hemorrhoids especially in the 3rd trimester (4). Other studies have stated that constipation should be treated and stool stiffness should be reduced to prevent hemorrhoids from occurring during pregnancy (21). In the current study, according to the BGS evaluation, most of the pregnant women (61.19%) had normal fecal type and 21.26% had constipation, which was seen at a higher rate in the group with hemorrhoids. According to these results, constipation was not found to be an important risk factor for hemorrhoids, which could be attributed to the general analysis rather than according to trimester.

In recent literature, the importance of adequate thoracic, abdominal and perineal muscle strength for pelvic floor rehabilitation and the continence mechanism have been frequently mentioned. Studies have demonstrated that a bad sacral and thoracic posture may be a cause of pelvic floor dyssynergia and the evaluation of lumbal lordosis is a reliable evaluation method of sacral and thoracic posture (23). It has also been shown that in individuals with lumbal hyperlordosis, the sacrum at an angle close to horizontal can change the position of the coccyx, the anorectal angle and the puborectalis muscle tone, which affect defecation (24). Although there is evidence in the literature that lumbal lordosis is significantly higher in individuals with constipation and urinary incontinence (23), there are no data of direct evaluation of the relationship between hemorrhoids and lumbal lordosis. In the current study, no difference was determined between the groups according to the presence of hemorrhoids in terms of lordosis value and it was therefore concluded that the change in lordosis during pregnancy was not a risk factor for the development of hemorrhoids.

In literature, although the relationship between waist, umblicus and hip circumference results and hemorrhoids has not been determined, abdominal obesity has been evaluated with waist circumference measured during normal expiration and increased circumference has been determined as a risk factor for hemorrhoids (5). The current study results showed that the increase in waist circumference measured in pregnant women is an important risk factor for hemorrhoids. This may be because an increase in body weight during pregnancy causes stress on the pelvic floor muscles.

To the best of our knowledge, no study in literature has examined the relationship between abdominal muscle strength and hemorrhoids. The current study results showed a significant difference in rectus abdominis, right and left external oblique muscle strength measurement results between the groups determined according to the presence of hemorrhoids, and all the muscle strength values were lower in the group with hemorrhoids. In addition, low rectus abdominis muscle strength was determined as a risk factor for hemorrhoids. This may be due to poor synergistic activity between the pelvic floor and the abdominal muscles, as a

result of a weak anterior ring of the abdominal muscle and pelvic floor muscle stability roller. No clear interpretation can be made of these results in the current study as there was no evaluation of the pelvic floor muscle strength. Further studies are needed on this subject.

In the literature, it has been reported that individuals with pelvic floor dysfunction have larger bi-iliac and bi-trochanteric pelvis widths (25). Sze et al., reported that pelvic transverse width was greater in those with pelvic organ prolapse compared to those with healthy pelvic organs (26). To the best of our knowledge, there is no study in the literature that has directly evaluated the relationship between bi-iliac and bi-trochanteric width and hemorrhoids. The current study results showed no difference in bi-iliac and bi-trochanteric widths between the groups determined according to the presence of hemorrhoids. However, an increased bi-iliac diameter was determine to be a risk factor for the development of hemorrhoids. This result can be considered important as this is the first study in literature to have examined the relationship between bi-iliac and bi-trochanteric diameter and hemorrhoid development in pregnancy.

In the study results, the highest grade of DRA was seen at the level of the umbilicus and this result supports the findings of Noble (27), and Akbayrak et al (28). There are opinions in the literature that DRA may be caused by dysfunction occurring in the abdominal muscles due to the loss of linea albane integrity (29). This dysfunction has been explained in literature by the relationship between pelvic floor muscle strength and endurance and abdominal muscle strength (28). Spitznagle et al. (29) stated that due to the synergistic relationship between the pelvic floor and the abdominal muscles, DRA may affect the pelvic floor system and therefore pelvic problems may occur. In the current study, an increase in DRA measured at the umbilicus level was seen to be an important risk factor for hemorrhoids. This can be considered important as this is the first study to have examined the effect of DRA on hemorrhoids in pregnancy.

Joint laxity is expected to increase as a result of hormonal changes during pregnancy (30). Studies in the literature evaluating the collagen-protein ratio have reported that a decrease in the number of collagen fibers may cause an increase in joint laxity and may constitute a risk factor for hemorrhoid formation (6). At the same time, epidemiological studies in the literature have indicated that the decrease in connective tissue stability is associated with the frequency of hemorrhoids (31). The results of the current study demonstrated that increased benign joint hypermobility is a risk factor for hemorrhoids. This can be considered important as this is the first study to have examined the effect of joint hypermobility on hemorrhoids during pregnancy.

Gravida was not found to be a risk factor associated with hemorrhoids in the current study, which confirmed the findings of Riss et al. (32) and Peery et al. (33). In previous study, risk factors associated with hemorrhoids have included high body mass index and high parity (21). In the current study, high parity was found to be a risk factor in all pregnant women, but there was no relationship between BMI and hemorrhoids.

In literature, the average fetus weight determined as a risk factor for hemorrhoids has beeen reported as 2800 g (21). The average fetus weight measured by ultrasound examination in the current study was 964.86 g. Although fetus weight has been reported as a risk factor for hemorrhoids in literature, it was not found to be significant in the current study, which could be attributed to the lower number of subjects in the 3rd trimester than in the 1st and 2nd trimesters and therefore the average fetal weight was lower than the previous findings in literature.

The strengths of this study are that it was prospective in design, and the evaluations and data analyses were performed by physiotherapists and doctors who are experts in their field. Limitations of the study could be said to be that the nutritional level of the participants during pregnancy was not evaluated and ano-rectal symptoms were determined by subjective evaluation. However, as the pregnant women included in the study were from different provinces of Turkey, objective assessments would have required additional time as there are no objective methods specific to pregnant women for hemorrhoid evaluation.

Conclusions

Hemorrhoids are seen at a high rate in the general population and are know to increase during the reproductive years and especially in pregnancy. This is the first study to have evaluated hemorrhoids and hemorrhoid-related symptoms during pregnancy and to have comprehensively evaluated the anthropometric and musculoskeletal risk factors associated with hemorrhoids with an appropriate sample size. The study results showed that parity is a risk factor for hemorrhoids, which was in accordance with previous findings in literature. In addition, for the first time it was demonstrated that waist circumference and bi-iliac width, rectus abdominis muscle weakness, the grade of DRA measured at the umbilicus level, and hypermobility were risk factors for hemorrhoids during pregnancy. In the treatment of hemorrhoids during pregnancy, the results of this study are important in terms of considering the risk factors associated with hemorrhoids, determining non-pharmacological treatment methods more clearly and providing appropriate treatments to prevent hemorrhoid development before pregnancy. In addition, based on the results of this study, pregnant women can be advised to increase their physical activity levels from the first trimester of pregnancy, pay attention to their fluid intake and diet, avoid constipation, and increase total body muscle strength, especially abdominal muscles.

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Işılay UĞUR[1], PT, MSc
Ayşegül ATLI[2], PT
Zeynep GÜVEN[1], PT, MSc
Vesile YILDIZ KABAK[1], PT, PhD
Ulaş ÖZCAN[3], MD
Songül ATASAVUN UYSAL[1], PT, PhD
Doğan AKDOĞAN[3], MD
Kadriye KAHVECİ[4], MD, PhD
Tülin DÜGER[1], PT, PhD

1 *Faculty of Physical Therapy and Rehabilitation Hacettepe University, Ankara, Turkey*
2 *Department of Physiotherapy, Haymana Vocational School, Ankara University, Ankara, Turkey*
3 *T.C. Ministry of Health Ulus State Hospital Palliative Care Centre Unit, Ankara, Turkey*
4 *University of Health Sciences, Ankara City Hospital, Department of Palliative Care Centre, Ankara, Turkey*

Correspondence (İletişim):

Işılay UĞUR, PT, PhD
Faculty of Physical Therapy and Rehabilitation Hacettepe University, Ankara, Turkey
ugurisilay@gmail.com
ORCID: 0000-0003-3666-8056
Ayşegül ATLI
E-mail: ayserose-atli@hotmail.com
ORCID: 0000-0003-4879-1553
Zeynep GÜVEN
E-mail: zeynepguven1995@hotmail.com
ORCID: 0000-0003-1947-7100
Vesile YILDIZ KABAK
E-mail: vesile_yldz@hotmail.com,
ORCID: 0000-0002-1559-1793
Ulaş ÖZCAN
E-mail: ulas79anes@hotmail.com
ORCID: 0000-0002-8776-7612
Songül ATASAVUN UYSAL
E-mail: songula@hacettepe.edu.tr
ORCID: 0000-0001-7334-411X
Doğan AKDOĞAN
E-mail: dr.dakdogan@hotmail.com
ORCID: 0000-0002-0970-1597
Kadriye KAHVECİ
E-mail: kahvecikadriye@gmail.com
ORCID: 0000-0002-9285-3195
Tülin DÜGER
E-mail: tduger@yahoo.com
ORCID: 0000-0002-3332-5958

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IDENTIFYING THE PHYSIOTHERAPY REQUIREMENTS OF PATIENTS IN PALLIATIVE CARE

ORIGINAL ARTICLE

ABSTRACT

Purpose: Palliative care has an important role in the late stages of diseases. Patients deal with many symptoms. Physiotherapy approaches are an essential part of palliative care in symptom control. This study was planned to investigate the level of independence of the patients, their performance status, symptoms, rehabilitation needs, and caregivers' expectations.

Methods: The study was designed as cross-sectional and descriptive. Ninety individuals aged between 18 and 65 years were included. Care needs during palliative care were assessed with the Palliative Performance Scale. Independence level was assessed by the Barthel Index. The severity of the symptoms that the patients frequently experienced was investigated. Caregivers reported their primary expectations from physiotherapy.

Results: The most common diagnosis was found to be cerebrovascular accidents. The mean age of the patients was 64±20 years. The mean age of the caregivers was 49±13 years. The mean the Palliative Performance Scale score was 31±17. Most of the patients were totally dependent according to the Barthel Index. Most of the patients faced symptoms, such as reduced muscle strength (94.44%), atrophy (93.33%) and swallowing problems (82.22%). Improved physical functions was the most reported expectation among caregivers.

Conclusion: Over 90% of the patients were totally dependent and they had to deal with many symptoms. This result highlights the importance of physiotherapy. Caregivers expected the patient to be able to meet their own needs independently. This is very important for the caregiver, and the patient and caregiver should be in cooperation with the physiotherapist.

Keywords: Caregivers, Expectations, Palliative care, Physiotherapists.

PALYATIF BAKIMDA HASTALARIN FİZYOTERAPİ GEREKSİNİMLERİNİN BELİRLENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Palyatif bakımın hastalıkların geç evrelerinde önemli bir rolü vardır. Hastalar birçok semptomla baş etmektedir. Fizyoterapi yaklaşımları semptom kontrolünde palyatif bakımın önemli bir parçasıdır. Bu çalışma, hastaların bağımsızlık düzeylerini, performans durumlarını, semptomlarını, rehabilitasyon ihtiyaçlarını ve bakım verenlerin beklentilerini araştırmak amacıyla planlanmıştır.

Yöntem: Çalışma kesitsel ve tanımlayıcı olarak tasarlanmıştır. 18-65 yaş grubu 90 birey dahil edildi. Palyatif bakımdaki hastaların bakım ihtiyaçları Palyatif Performans Ölçeği ile değerlendirildi. Bağımsızlık düzeyi Barthel Endeksi ile değerlendirildi. Hastaların sıklıkla yaşadığı semptomların şiddeti araştırıldı. Bakım verenler, fizyoterapiden birincil beklentilerini bildirdiler.

Sonuçlar: En çok raporlanan tanı serebrovasküler olay oldu. Hastaların yaş ortalaması 64±20 idi. Bakım verenlerin yaş ortalaması 49±13 idi. Ortalama Palyatif Performans Ölçeği skoru 31±17 idi. Hastaların çoğu Barthel İndeksine göre tamamen bağımlıydı. Hastaların çoğu azalmış kas gücü (% 94,44), atrofi (% 93,33) ve yutma problemleri (% 82,22) gibi semptomlarla karşı karşıya kaldığını belirtti. Bakım verenlerin beklentisi, hastanın fiziksel fonksiyonlarının iyileşmesi yönündeydi.

Tartışma: Hastaların %90'ından fazlası tamamen bağımlıydı ve semptomlarla uğraşmak zorunda kaldıklarını belirttiler. Bu sonuç fizyoterapinin önemini vurgulamaktadır. Bakım verenler hastanın ihtiyaçlarını bağımsız olarak karşılamasını istediğini belirttiler. Bu durum bakım veren için oldukça önemlidir ve hasta ve bakımverenler fizyoterapistlerle işbirliği içinde olmalıdır.

Anahtar Kelimeler: Bakım verenler, Beklentiler, Palyatif bakım, Fizyoterapistler.

INTRODUCTION

Palliative care includes the management of symptoms experienced by terminally ill patients. According to the World Health Organization, palliative care is a healthcare procedure aiming to decrease symptoms and to improve patients' quality of life (QOL). Multidisciplinary healthcare is essential for the management of different aspects of the problems experienced by patients (1-3).

Symptoms of advanced cancer patients or those hospitalized for palliative care/hospice care have been reported previously. Based on these reports, patients hospitalized for palliative care may experience pain, fatigue, lack of energy, somatic complications, emotional problems, and immobilization-related side effects including pressure ulcers, muscle weakness, joint limitations, cardiopulmonary side effects, and physical and performance deficits (4, 5). These symptoms negatively impact patients' activities of daily living (ADL), functional capacity, and QOL (6, 7). Accordingly, supportive care interventions aiming for symptom management is an essential part of palliative care. There are a number of studies investigating the effects of physical therapy interventions in a palliative care setting. Physical therapists help individuals to decrease symptom severity and to increase independence and functionality in daily life during palliative care (8, 9). Management of physical problems includes improving mobility, strength, flexibility, endurance, coordination, balance, gait, breathing, exercise tolerance, and energy expenditure (7, 10). Symptom control by physical therapy is applicable in patients experiencing several symptoms such as pain, fatigue, weakness, joint limitations, cough, and shortness of breath (11, 12). In Turkey, there are limited data regarding physiotherapy assessments or interventions in terminally ill patients receiving palliative care. To plan effective physical therapy interventions in a palliative care setting, this study was planned to examine physical therapy needs and problems of palliative care patients. Therefore, the present study aimed to determine palliative care patients' independency level in activities of daily living, their performance status, symptoms, physical therapy and rehabilitation needs, and caregivers' expectations in a palliative care setting in Turkey.

METHODS

Study design and patients

This research was conducted between June 2018 and September 2019 in Republic of Turkey, Ministry of Health, Ulus State Hospital Palliative Care Centre. The study was designed as cross-sectional and descriptive. The Hacettepe University Ethics Committee for Non-Interventional Clinical Research approved the present study with the decision number GO 18\700. The present study was conducted in accordance with the principles defined in the Helsinki Declaration. Participants were informed about the study and a signed written consent form was obtained from all patients. The study included 18- to 65-year-old volunteers who were being treated at a palliative care unit. Patients who did not meet the inclusion criteria, did not sign the consent form, or withdrew were not included. Age, gender, height, weight, body mass index (BMI), hospitalization date, marital status, the presence of health insurance, diagnosis, and previous treatments were recorded.

Palliative Performance Scale

The Palliative Performance Scale is a reliable and valid tool that has been used to measure functional performance and predict survival among palliative care cancer patients. The PPS is a modification of the Karnofsky Performance Scale. PPS was originally developed for cancer patients and later adapted to be more generalizable to other end-of-life diagnosis. PPS was developed by Anderson et al. in 1996 to determine the care needs of patients receiving palliative care. It includes five sub-headings: ambulation, activity level and evidence of disease, self-care, oral intake, and level of consciousness. The item that best describes the patients' care need is determined in the scale and the percentage value (PPS%) of the items is recorded. Each of the five domains is divided into 11 levels ranging from 0% to 100% in 10%-point intervals, with 0% indicating death and 100% being fully ambulatory and healthy. Turkish validity and reliability study of this scale was done by Oğuz et al. (13, 14).

The Barthel Index

The Barthel Index (BI) was developed by Mahoney and Barthel to measure physical and social func-

tion in daily life. This index defines activity capacity with a scale ranging from 0 (full dependence) to 100 (full independence). The BI score is classified into five categories: total dependence (0-20 points), severe dependence (21-60 points), moderate dependence (61-90 points), slight dependence (91-99 points) and total independence (100 points). The higher scores represent higher functional independence. The BI includes 10 items: nutrition, bathing, personal care, dressing, toilet use, mobility on flat surfaces (immobile, wheelchair use, assisted or independent walking), transfer (wheelchair to bed and vice versa), stair climbing, bowel, and bladder continence. Turkish validity and reliability study of this scale was done by Küçükdeveci et al. (15, 16).

Determination of Physiotherapy Needs

In this section, patient evaluations were conducted in two parts. The results were obtained by evaluating the answers of the physiotherapist and the caregiver. Clinical evaluations about atrophy, muscle strength, rigidity, decubitus ulcer, spasticity, joint movement limitation, flaccidity, oedema, lymphedema, contracture, swallowing problems, phlegm, constipation, and coughing were performed by the physiotherapist. The items were answered as "yes" or "no". Physiotherapy needs of the palliative care patients and the expectations of the caregivers were evaluated. Evaluations were gathered under three main titles as: improving physical functions, increasing participation in daily life activities, and relief of symptoms (9, 17, 18).

Statistical Analysis

Analyses were carried out using SPSS 22 (SPSS Inc. Chicago IL, USA) program. Descriptive statistics were calculated for all variables. Descriptive data were calculated as percentage, mean, and standard deviation.

RESULTS

A total of 90 palliative care patients (35 females, 55 males) were included in the present study. The mean age of the participants was 64±20 years (Ta-

Table 1. Demographic Information of The Participants

		Mean ± SD
Age (years)		64±20
Caregiver's Age (years)		49±13
Body Mass Index (kg/m²)		23.27±4.85
Duration of Hospital Stay (day)		32±37
Gender	**n**	**%**
Female	35	38.88
Male	55	61.12
Marital Status		
Single	28	31.11
Married	62	68.89
Separated	-	-
Widowed	-	-
Health Insurance Status		
Yes	84	93.33
No	6	6.67
Caregiver's Gender		
Female	61	67.72
Male	29	32.28
Caregiver's Degree		
Family	79	87.78
Nurse	11	12.22

SD:Standard Deviation, n: Number of Participants

Table 2. Diagnoses of The Participants

	n	%
Cerebrovascular Accidents	40	44.44
Cancer	26	28.89
Alzheimer's Disease	7	7.78
Chronic Obstructive Pulmonary Disease	4	4.44
Health Failure	3	3.33
Parkinson	3	3.33
Pneumonitis	2	2.22
Amyotrophic Lateral Sclerosis	1	1.11
Bullet Injury	1	1.11
Myopathy	1	1.11
Multiple Sclerosis	1	1.11
Anaphylactic Shock	1	1.11

n: Number of Participants

Table 3. The Barthel Index Scores of The Participants

	n	%
Total Dependence (0-20)	85	94.45
Severe Dependence (21-60)	3	3.33
Moderate Dependence (62-90)	2	2.22
Slight Dependence (91-99)	-	-
Total Independence (100)	-	-

n: Number of Participants

ble 1). Cerebrovascular accident (44.44%), cancer (28.89%), and Alzheimer (7.78%) were the most common diagnosis in palliative care patients (Table 2).

A mean score of the Palliative Performance Scale of patients was 31±17. The mean Barthel Index score was 5.79±13.50 points. According to the results, 94.45% of the patients were totally dependent, 3.33% were severely dependent, and 2.22% were moderately dependent (Table 3).

Poor muscle strength (94.44%), atrophy (93.33%), and swallowing problems (82.22%) were the most common problems (Table 4).

It was observed that 66.67% of the caregivers expect improvement in the physical function of the patients, 52.22% expect an increase in participation in daily life activities, and 13.33% expect an increase in relief of symptoms (Table 5).

DISCUSSION

This study documented a group of palliative care patients' functional status, physiotherapy needs, and mobility and performance levels. Majority of the participants were totally dependent in the present study. Muscle weakness, atrophy, and swallowing problems were the most prevalent symptoms that needed physiotherapy and rehabilitation. The most common expectations of the caregivers from the physiotherapy and rehabilitation were improvement in physical functions and activities of daily living, and decrease in symptoms.

It was shown that the functional level of patients receiving palliative care decreases (19). Patients faced severe constraints both in the palliative care process and in daily life. Uysal et al. reported the mean Palliative Performance Scale as 45 points in patients diagnosed with cancer (20). Özalp et al. calculated the mean Palliative Performance Score as 40 points in cancer patients receiving palliative

Table 4. Physical Problems and Symptoms of The Participants

	n	%
Poor Muscle Strength	85	94.44
Atrophy	84	93.33
Swallowing Problems	74	82.22
Phlegm	70	77.78
Coughing	61	67.78
Constipation	58	64.44
Joint Limitation	52	57.78
Contracture	46	51.11
Spasticity	29	32.22
Oedema	21	23.33
Flaccidity	17	18.89
Decubitus Ulcers	17	18.89
Rigidity	11	12.22
Lymphedema	5	5.55

n: Number of Participants

Table 5. Caregiver Expectations from Physiotherapy Service

	n	%
Improving physical functions	60	66.67
Increasing participation in daily life activities	47	52.22
Relief of symptoms	12	13.33

n: Number of Participants

care (90% metastasis) (4). The mean Palliative Performance Scale of the patients was 31 points in the present study. In the present study, most of the patients were hospitalized at the palliative care centre due to cerebrovascular accident, and their illnesses were severe. The average age was high, and the majority of the patients were from the geriatric group (64±20 years). These results may have been because the diseases were at an advanced stage and poor prognosis may have reduced the performance of the patients.

Motor symptoms (tremor, slowness in movements, walking disorders) and non-motor symptoms (pain, psychological problems, sleep disorders) negatively affect the life of patients (21, 22). The symptom reported most often in this study was reduced muscle strength. Atrophy, swallowing problems, phlegm, couching, constipation, joint movement limitation, and contracture were the other most prevalent symptoms, in this order. There are many studies in the literature assessing the symptoms of palliative care patients. A study indicated that dyspnoea (68%-98%), coughing (59%-94%), and depression (10%-49%) were observed in lung diseases, as well as sleep disorders, weight loss, fatigue, and anorexia (23). Fong et al. indicated that disease duration and treatment regimen may have an effect on symptoms on the musculoskeletal system problems (24). McLeod et al. investigated which exercises are preferred by physiotherapists in palliative care. They found that physiotherapists preferred mobilization, range of motion, massage, and breathing exercises, balance exercises, and transfer activities in routine rehabilitation programs. In addition, they stated that they provide training to patients who use assistive devices (25).

Caregivers and patients in the present study were asked about the condition they experienced most often after diagnosis, and their answers were: loss of functionality (walking, using their arms) and de-

creasing symptoms. Most caregivers have stated that patients wanted to be able to take care of themselves, stand up and walk independently. In a study including 53 patients and caregivers, the priorities of the caregivers and patients were similar. The expectations from physiotherapy are to return to the condition before the disease, to be able to move the arm and leg, and to meet basic needs (26). Studies have indicated that 85% of the patients need an assistive device in their daily life activities (19). A large proportion of patients experience difficulty maintaining their daily life. Roh et al. linked excessive restrictions and low levels of mobility in cancer patients to symptoms such as sleep disorder, fatigue, and pain (27). Restrictions may be due to the fact that the disease is at an advanced stage and the poor prognosis may have reduced the performance of the patients, both of which may be a factor that increases caregivers' responsibility. Similar to previous studies, we found how important function and meeting basic needs are in sustaining life. In this sense, physiotherapists have a very crucial role in returning patients to their pre-disease functionality. First, the needs must be determined correctly and the right targets must be identified. Objective-oriented exercises such as transfer exercises, strengthening exercises, and balance exercises will facilitate the use of limbs for a specific purpose and help them to perform basic self-care activities better.

This study had several limitations. The small sample size may have affected the results. We could not have a larger sample because there are few hospitals providing palliative care in Turkey. Our study was conducted in one centre, so the number of patients may have been insufficient. Another limitation was that the duration of hospital stay of the patients in the study was highly variable. This may have affected the caregiver's perspective on treatment and the patient's symptom level. Finally, the vast majority of the patients were fully dependent, so we were unable to identify symptoms and physiotherapy needs in dependent people.

This study evaluated palliative care patients' symptoms and independence levels, and caregivers' expectations from physiotherapy. Caregivers were aware of the importance and beneficial aspects of physiotherapy. The majority of the patients experienced several symptoms. Muscle weakness, atrophy, and swallowing problems were the most prevalent symptoms. With this study, we think that we highlighted the need for physiotherapy and rehabilitation services in patients receiving palliative care. Further studies, in parallel with the present study, involving an exercise program and a more standardized approach (age, duration of hospitalization, diagnosis) to determine symptoms are needed.

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Hayriye YILMAZ, PT, MSc[1]
Gulsah OZSOY, PT, PhD[2*]
Mehmet Gürhan KARAKAYA, PT, PhD[3]

1 *İzmir Bozyaka Education and Research Hospital, Izmir, Turkey*
2 *Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Selcuk University, Konya, Turkey*
3 *Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Mugla Sıtkı Kocman University, Mugla, Turkey*

Correspondence (İletişim):

Gulsah OZSOY
Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Selcuk University, Konya, Turkey
fzt.gulsah@hotmail.com
ORCID: 0000-0001-5678-771X

Hayriye YILMAZ
E-mail: fzthayriyeyilmaz@yahoo.com
ORCID ID: 0000-0002-1151-7190

Mehmet Gürhan KARAKAYA
E-mail: karakaya70@yahoo.com
ORCID ID: 0000-0002-2395-649X

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BALANCE PERFORMANCE IN DUAL TASK IN PATIENTS WITH CERVICAL DISC HERNIATION RELATED CHRONIC NECK PAIN: A COMPARATIVE STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of the study was to compare balance performance in dual task between patients with cervical disc herniation (CDH) related chronic neck pain and asymptomatic controls.

Methods: Thirty-two patients with CDH related chronic neck pain and twenty-three age and sex-matched asymptomatic controls participated in this cross-sectional controlled study. The modified clinical test of sensory integration of balance (mCTSIB), athletic single leg test (ASLT), limits of stability (LOS), and fall risk assessment were performed with and without a cognitive task. Dual task interference (DTI) was assessed.

Results: According to our findings, the change in the mCTSIB values (except standing with eyes closed on a firm surface) and fall risk scores was greater in the CDH group compared to the control group ($p<0.05$). Additionally, the DTI of the mCTSIB values (except standing with eyes closed on a firm surface) and fall risk scores were higher in the CDH group than in the control group ($p < 0.05$).

Conclusions: The results of study suggest that patients with CDH related chronic neck pain have poorer postural control and increased fall risk under dual task conditions. Patients with CDH related chronic neck pain should participate in rehabilitation program to increase balance and postural control.

Key Words: Balance, Cervical Disc Herniation, Disability, Dual-Task, Postural Control

SERVİKAL DİSK HERNİASYONUYLA İLİŞKİLİ KRONİK BOYUN AĞRISI OLAN HASTALARDA İKİLİ GÖREVDE DENGE PERFORMANSI: KARŞILAŞTIRMALI BİR ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çalışmanın amacı, servikal disk herniasyonu (SDH) ile ilişkili kronik boyun ağrısı olan hastalar ve asemptomatik kontroller arasındaki ikili görevdeki denge performansını karşılaştırmaktı.

Yöntem: Bu kesitsel kontrollü çalışmaya SDH ile ilişkili kronik boyun ağrısı olan otuz iki hasta ve yaş/cinsiyet uyumlu yirmi üç asemptomatik kontrol katıldı. Modifiye Klinik Duyu Entegrasyon Testi (mKDET), atletik tek bacak testi (ATBT), stabilite limitleri (SL) ve düşme riski değerlendirmesi, bilişsel bir görevle ve bu görev olmadan gerçekleştirildi. İkili görev etkileşimi (İGE) değerlendirildi.

Sonuçlar: Bulgularımıza göre mKDET değerlerindeki değişim (gözler kapalı olarak sert bir zeminde ayakta durma dışında) ve düşme risk skorlarındaki değişim SDH grubunda kontrol grubuna göre daha fazlaydı ($p<0,05$). Ek olarak, mKDET değerlerinin İGE 'si (gözler kapalı bir zeminde ayakta durmak hariç) ve düşme riski skorları SDH grubunda kontrol grubuna göre daha yüksekti ($p <0,05$).

Tartışma: Çalışmanın sonuçları, SDH ile ilişkili kronik boyun ağrısı olan hastaların, ikili görev koşulları altında daha zayıf postüral kontrole ve artan düşme riskine sahip olduğunu göstermektedir. SDH ile ilişkili kronik boyun ağrısı olan hastalar denge ve postüral kontrolü artırmak için rehabilitasyon programına katılmalıdır.

Anahtar Kelimeler: Denge, Servikal Disk Hernisi, Özürlülük, İkili Görev, Postüral Kontrol

INTRODUCTION

Dual-task is defined as doing more than one task at a time, and fail of this one or more simultaneous tasks is called as dual task interference (DTI) (1). The frontal lobe is responsible for higher cognitive functions such as memory, motor function, problem solving, and dual-tasking (2). Dysfunction of the frontal lobe may result in a consequent reduction in attentional capacity and this is thought to be the neurological background of DTI. (3). Therefore, in conditions such as aging and neurological diseases, DTI increases (1, 4). Chronic pain is another condition which is related with cognitive impairments and alters the structure of the brain, especially the frontal lobe (5, 6). Therefore, chronic pain may also increase the DTI (7).

Higher DTI during postural control increases risk of falls, disability and death (8, 9), and therefore, it is important to determine the effects of pain related disability on dual task performance. Intense pain and moderate disability are seen most patients with symptomatic cervical disc herniation (CDH) (10). Since neck pain and disability affect negatively neck motion and motor control (11), it is highly likely that patients with neck pain related disability would display DTI during postural control with a cognitive task. In addition, the cervical region, its rich proprioceptive content, the cervical afferents that form the basis of the vestibular reflex, and the visual sense perception associated with neck movements, affect all three mechanisms that are effective in providing postural control (12). A problem which might arise in cervical region can be lead to significant postural instability and fear of falling (13). Additionally, it is demonstrated that patients with neck pain have altered spatiotemporal parameters and neck and trunk kinematics during walking while performing concurrent head movements (14, 15).

As mentioned above, it is seen that the effects of neck pain and dual task are mostly emphasized. To the best our knowledge, there is no study directly investigating the relationship between CDH and dual task in the literature. However, CDH is a frequent reason for neck pain in adults (16). It is very important for patients with CDH to perform more than one task at the same time for many activities of daily living. However, considering the disruptions seen even in single tasks due to postural instability, it is possible that problems may arise in performing dual-task focused activities. Therefore, the aim of this study was to compare balance performance in dual task between patients with CDH related chronic neck pain and asymptomatic controls.

METHODS

Study design and participants

This study was designed cross-sectional controlled study (ClinicalTrials.gov Identifier: NCT05338788). Thirty-two patients with CDH related chronic neck pain and twenty-three age and sex-matched asymptomatic controls participated in this study.

Patients who aged 20–50 years, had neck pain for at least 12 weeks, having disc prolapse with neck pain symptom between C3 and C7, pathology confirmed by magnetic resonance imaging, no disease other than CDH that might affect balance, no vertebrobasilar insufficiency, no tumour, trauma, fracture pathology in the spinal region and no history of spine surgery were included. People with cognitive, orthopaedic or neurological diseases that could negatively affect the evaluations were excluded. Age- and sex-matched asymptomatic controls without any known disease diagnosis and health problems that would affect the evaluations were included.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol was approved by the local ethics committee of Izmir Bozyaka Education and Research Hospital (Report number and date = 08 and 08.05.2019). Informed consent was obtained from all participants included in the study.

Data collection

The Neck Disability Index (NDI): The patients' self-reported neck pain related disability was assessed with the NDI. It assesses the level of neck pain related disability during activities of daily liv-

ing. The NDI is 10-item questionnaire and evaluated between 0 and 50 points. Increasing score is associated with increased disability (17, 18).

The Biodex Balance System (BBS; Biodex Medical Systems, Shirley, New York, USA) was used to assess postural control. This system allows individuals to measure their stability limits. It also examines the control of the center of gravity on the support surface and balance abilities when trying to move it. The evaluated parameters of this system are presented below:

-The modified Clinical Test of Sensory Integration of Balance (mCTSIB): The mCTSIB was used to assess individuals' capability to use sensory inputs for balance. Four conditions (standing with eyes open or closed on a firm or foam surface) were assessed. An increasing score indicates impaired postural control (19).

-Athletic Single Leg Test (ASLT): The evaluation was made with eyes open and closed on one leg (dominant limb) on a firm floor on the balance device platform. Each test lasted 10 seconds and with 3 repetitions. The average of 3 measurements was recorded as the 'Athletic Single Leg Test' score. As the score increases, the balance deteriorates (20).

-Limits of Stability (LOS): This test is the best test that measures dynamic control among the standard sway tests. It is a test with a total of nine goals by standing on the platform and hitting the targets in one centre and eight different directions on the screen (21). As the score increases, dynamic control deteriorates.

-Fall risk assessment: The pre-test platform level was adjusted so that the starting position was 12 and the ending position was 8. A test protocol was created, consisting of three tests (20 seconds each) for a total of 60 seconds, and a 10-second rest period was given between each test. The mean of these three tests was accepted as the fall risk index score. The higher the score is associated with the higher the risk of falling (22).

Measurement procedure

In order to avoid the order bias of postural control measurements during "Single-task" and "Dual-task" for each case, the order of the measurements was determined by randomization on the first day by using sealed envelope method. After single/double task randomization was made, the order of tests was also randomized by using sealed envelopes containing two different orders (1-mCTSIB, 2-ASLT, 3-Fall test, 4-LOS and 1- LOS, 2- Fall test, 3- ASLT, 4-mCTSIB).

Before starting the evaluations, the participants were informed about the tests. Considering methodological bias, the same investigator performed all assessments and all participants received standardized and identical instructions.

Single and dual task measurements were made as follows:

Single task measurements involved the measurement of balance parameters by using Biodex Balance System without any additional cognitive task. For assessment of dual task performance, the participants were asked to perform an additional cognitive task (counting backwards from 200 by three or seven) during measurements (23).

DTI values were calculated for all balance parameters using the formulas below (24):

DTI %= (Dual Task-Single Task)/Single Task*100

Sample size

A previous study has shown that the balance is disturbed with dual task ($p<0.05$) (25). Based on the findings of that study, the minimum required sample size for an analysis was calculated as 31 participants for the probability level of 0.05; the anticipated effect size as 0.458; and a statistical power level of 80% when using G*Power Software (version 3.1.9.2).

Data analysis

The data was analysed by using the IBM® SPSS® Statistics for Windows software (ver. 22.0; IBM Corp., NY, USA). Shapiro–Wilk test and histograms were used to check normality. To compare the independent groups, independent samples t-test, Mann-Whitney U Test or chi-square test were used. The paired sample t-test was used to assess the mean difference between single and dual tasks within the groups. Two-way repeated measures analysis of variance was used to compare 'condition' and 'group*condition' interaction between the groups.

Table 1. Characteristics of the Participants

	CDH Group (n =32)	Asymptomatic Group (n=23)	p
Age (year)	41.09±5.68	39.61±3.60	0.275[a]
Gender (Female, n (%))	19 (59.4)	12 (52.2)	0.595[b]
Height (cm)	168.69±9.24	172.48±9.46	0.143[a]
Weight (kg)	75.09±13.10	70.30±11.47	0.165[a]
Body mass index (kg/m²)	26.35±3.94	23.52±2.39	0.004[a]
Neck Disability Index	12.88±4.77		
Cervical pain duration (months)	36.00 (12.00-72.00)		
Disc herniation level			
One level disc herniation (n (%))	16 (50.0)		
Two level disc herniation (n (%))	15 (46.9)		
Three level disc herniation (n (%))	1 (3.1)		
Disc herniation stages			
Bulging (n (%))	8 (25.0)		
Protrusion (n (%))	15 (49.6)		
Bulging+ Protrusion (n (%))	9 (28.1)		

a: Student t Test, b: Chi-square Test.
Values are expressed as mean±standard deviation for continuous variables and 'n' were reported for categorical variables.

RESULTS

Based on the data obtained from thirty-two patients with CDH related chronic neck pain (59.4 % female) and twenty-three controls (52.2 % female) were analysed. The demographic characteristics (age, sex, height, weight) except body mass index of the two groups were similar (p > 0.05, Table 1). The clinic characteristics (neck disability level, cervical pain duration, disc herniation level, disc herni-

Table 2. Comparison of Outcomes

Outcome Measures	CDH Group (n =32)		p[1]	Asymptomatic Group (n=23)		p[1]	p[2]	
	Single Task	Dual Task		Single Task	Dual Task		Condition	Group* Condition
mCTSIB								
EO-Firm sway index (score)	0.47±0.13	0.70±0.20	**<0.001**	0.54±0.12	0.58±0.17	0.265	**<0.001 (0.215)**	**0.009 (0.121)**
EC-Firm sway index (score)	0.70±0.20	0.81±0.27	0.065	0.83±0.36	0.91±0.29	0.224	**0.034 (0.082)**	0.654 (0.004)
EO-Foam sway index (score)	0.68±0.20	1.06±0.36	**<0.001**	0.87±0.48	0.93±0.26	0.618	**0.002 (0.169)**	**0.023 (0.094)**
EC-Foam sway index (score)	1.35±0.47	1.66±0.45	**0.003**	1.82±0.26	1.85±0.21	0.727	**0.013 (0.111)**	**0.034 (0.082)**
ASLT								
Overall (score)	0.78±0.23	0.94±0.47	0.051	0.62±0.15	0.66±0.19	0.291	**0.046 (0.073)**	0.261 (0.024)
AP (score)	0.50±0.14	0.64±0.39	0.065	0.47±0.15	0.50±0.12	0.295	0.059 (0.066)	0.261 (0.024)
ML (score)	0.50±0.23	0.57±0.26	0.183	0.45±0.12	0.46±0.11	0.517	0.182 (0.033)	0.424 (0.012)
LOS								
Overall (score)	44.13±9.04	46.50±12.07	0.263	42.74±8.77	44.87±7.07	0.225	0.120 (0.045)	0.932 (< 0.001)
Time (sn)	47.66±8.81	49.47±13.09	0.367	53.35±11.28	54.61±6.76	0.534	0.292 (0.021)	0.849 (0.001)
Fall risk assessment								
Fall risk (score)	1.30±0.33	1.71±0.36	**<0.001**	1.43±0.45	1.49±0.35	0.570	**<0.001 (0.220)**	**0.006 (0.136)**

mCTSIB: Modified Clinical Test for Sensory Integration of Balance, ASLT: Athletic Single Leg Test, AP: Anteroposterior, ML: mediolateral, EO: Eyes open, EC: Eyes closed, Firm: Firm surface, Foam: Foam surface, LOS: Limits of Stability.
Note: p1, paired sample t-test; p2, two-way repeated measures analysis of variance. Values are expressed as mean ± standard deviation. Figures in parentheses are effect sizes.

Table 3. Comparison of Dual-Task Interference

	CDH Group (n =32)	Asymptomatic Group (n=23)	p
mCTSIB			
DTI EO-Firm sway index %	39.95 (0.39-80.44)	5.55 (-11.76-14.03)	**0.007**
DTI EC-Firm sway index %	19.64 (-9.01-54.22)	8.75 (-10.71-42.85)	0.726
DTI EO-Foam sway index %	54.88 (12.57-91.64)	27.58 (0.00-61.76)	**0.022**
DTI EC-Foam sway index %	18.12 (-2.01-58.86)	2.23 (-6.63-11.79)	**0.024**
ASLT			
DTI Overall %	18.33 (-12.15-48.21)	0.00 (-16.66-20.00)	0.146
DTI AP %	0.00 (-20.00-75.00)	0.00 (-12.50-25.00)	0.869
DTI ML %	22.50 (0.00-44.09)	0.00 (-14.28-25.00)	0.199
LOS			
DTI Overall %	3.08 (-14.45-20.78)	3.70 (-4.25-10.86)	0.865
DTI Time %	0.34 (-12.79-12.54)	3.50 (-10.76-13.33)	0.959
Fall risk assessment			
DTI Fall risk %	26.78 (1.92-55.82)	10.00 (-9.52-25.00)	**0.019**

mCTSIB: Modified Clinical Test for Sensory Integration of Balance, ASLT: Athletic Single Leg Test, AP: Anterior-posterior, ML: mediolateral, EO: Eyes open, EC: Eyes closed, Firm: Firm surface, Foam: Foam surface, LOS: Limits of Stability.
Note: Mann-Whitney U Test Values are expressed as median (25-75 quartiles)

ation stages) of the patients are presented in Table 1.

According to our findings, the change in the mCTSIB values (except standing with eyes closed on a firm surface) and fall risk scores was less than in the control group compared to the CDH group ($p<0.05$, Table 2). Additionally, the ASLT and the LOS scores were similar between the groups (group × condition interactions) ($p>0.05$, Table 2).

The DTI of the mCTSIB values (except standing with eyes closed on a firm surface) and fall risk scores were higher in the CDH group than in the control group ($p < 0.05$, Table 3). There was no significant difference in DTI in the ASLT and the LOS tests between the two groups ($p>0.05$, Table 3).

DISCUSSION

The primary finding of the study reported that the impairment in postural control performance and increased risk of falling throughout dual task was more prominent in patients with CDH related chronic neck pain than in asymptomatic controls.

Postural control is of vital importance for the maintenance of activities of daily living (26). It has been reported that deterioration in postural control is increased in patients with chronic neck pain compared to healthy individuals (27). The postural control problems increase risk of fall and mortality (28). Also, a previous review noted the negative effects of dual tasks on postural stability (9). The DTI is a consequences of frontal lobe dysfunction (2). Additionally, chronic pain alters the structure of the brain especially frontal lobe (6). Hamacher et al. showed that chronic pain increases the DTI by decreasing motor-cognitive dual-task performance capacity (7). A previous study has shown that patients with chronic neck pain have more severe impairments in postural control of different sensory and dual-task conditions. (14). A systematic review postulated that neck proprioception is deteriorated in people with neck pain compared to healthy controls (29). Neck pain has been shown to impair input from cervical mechanoreceptors and it has been claimed that impaired cervical input may be the reason for poorer balance in people with neck pain (29, 30). When the studies in the literature are examined, it is seen that the effects of neck pain and dual task are mostly emphasized. To the best our knowledge, there is no study directly investigating the relationship between CDH and dual task in the literature. As you know, cervical

disc herniation is a frequent reason for neck pain in adults (16). Our study suggests that patients with CDH related chronic neck pain have poorer postural control under concurrent dual tasks condition. All the three mechanisms which are influential in maintaining postural control are influenced by the cervical region, its rich proprioceptive content, the cervical afferents which create the basis of the vestibular reflex, and the perception of visual sense linked with neck movements (12). Additionally, chronic pain which alters the structure of the brain, especially the frontal lobe, increase the DTI (5). For these reasons, a situation that will affect the cervical region such as pain can explain cause of deterioration of postural control during dual task conditions in patients with CDH.

Dual-task testing is a widely used method of evaluating the relationship between cognition and mobility. Additionally, the DTI is associated with future fall risk, and this association is stronger than that for single-task conditions (31). Chronic pain has been shown to decrease the ability to complete motor-cognitive dual tasks. These effects are generated by central mechanisms in which pain impairs executive functioning, potentially increasing the chance of falling (7). Additionally, dual-task measures were more predictive of falls than single-task measures (32). The gap in performance between dual-task and single-task walking trials has been shown to be important to discriminate between falls (33). Our study suggests that patients with CDH related chronic neck pain have increased fall risk compared controls under concurrent dual tasks condition.

This study had some limitations. First, the patients with cervical disc herniation related chronic neck pain had mild neck pain related disability (NDI score=12.88±4.77). The results may be different, especially in patients with high disability due to neck pain. Second, this study had a cross-sectional design. Making inferences concerning the causality relationship among the variables is impossible due to the study's cross-sectional design. Third, only motor effects were evaluated with the cognitive task given as dual task in our study. However, in these patients, cognitive impairment may be observed in addition to motor impairment during the dual task. Future studies can be conducted with a design to evaluate both impairments.

The results of study suggest that patients with CDH related chronic neck pain have poorer postural control and increased fall risk under dual task conditions. Patients with CDH related chronic neck pain should participate in rehabilitation program to increase balance and postural control.

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Author Contributions: HY: Conceptualization, Methodology, Investigation, Writing-Original draft preparation, Visualization. GO: Conceptualization, Methodology, Formal Analysis, Writing-Original draft preparation, Visualization. MGK: Conceptualization, Methodology, Writing- Reviewing and Editing, Project administration, Supervision.

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Muhammed Taha TUFEK, MSc., PT[1]
Cansu GEVREK-ASLAN, MSc., PT[2]
Omur CAGLAR , Prof., MD[3]
Gizem Irem KINIKLI, Prof., PT[1]

1 *Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Department of Musculoskeletal Physiotherapy and Rehabilitation, Ankara, Turkey.*
2 *Ankara Medipol University, Vocational School of Health Services, Department of Therapy and Rehabilitation, Programme of Physiotherapy, Ankara, Turkey*
3 *Hacettepe University, Faculty of Medicine, Department of Orthopedics and Traumatology, Ankara, Turkey.*

Correspondence (İletişim):

Cansu GEVREK-ASLAN, MSc., PT
E-mail: gevrekcansu@gmail.com
Ankara Medipol University, Vocational School of Health Services, Department of Therapy and Rehabilitation, Programme of Physiotherapy, Ankara, Turkey

1Muhammed Taha TUFEK
E-mail: m.taha.tufek@gmail.com
ORCID: 0000-0002-9356-4096

Cansu GEVREK ASLAN
E-mail: gevrekcansu@gmail.com
ORCID: 0000-0003-0750-3033

Omur CAGLAR
E-mail: dromurcaglar@gmail.com
ORCID: 0000-0002-0346-8528

Gizem İrem KINIKLI
E-mail: cguvendik@hotmail.com
ORCID: 0000-0003-1013-6393

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LONG-TERM FUNCTIONAL OUTCOMES AND QUALITY OF LIFE IN YOUNG ADULTS WITH INTERNAL FIXATION OF FEMORAL SHAFT FRACTURE: A CROSS-SECTIONAL STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: Although internal fixation surgery of femoral shaft fracture (FSF) has high rates of union, it affects the patient's functionality and quality of life due to additional health conditions depending on the traumatic nature of these injuries. This cross-sectional study aimed to investigate the long-term functional outcomes and quality of life of young adults who underwent internal fixation of isolated FSF to compare with healthy peers.

Methods: The Harris Hip Score (HHS) and Stair Climb Test (SCT) were used to evaluate the functionality of the participants. The EuroQol 5-Dimension Questionnaire (EQ-5D) was used to assess the quality of life.

Results: Twenty young adult volunteers with internal fixation surgery aged 18-55 years are included in the FSF group (mean age: 39.55±11.92 years; duration after surgery: 28±7.2 months) and 20 healthy peers (mean age: 42.75±8.83 years) as the control group. The HHS and EQ-5D scores were lower ($p<0.001$) in patients with FSF; however, the SCT test time was longer in patients with FSF compared to healthy controls ($p<0.001$).

Conclusion: The results of the present study demonstrated that functional outcomes and quality of life in patients with FSF did not improve well enough compared to healthy peers 2 years after internal fixation surgery. We suggest that assessment of patients with FSF in a long-term period is needed, even after fracture union, to have a better outcome.

Keywords: Femoral Fractures, Femur, Function, Quality of life

FEMUR ŞAFT KIRIĞINA BAĞLI İNTERNAL FİKSASYON CERRAHİSİ GEÇİRMİŞ GENÇ ERİŞKİNLERDE GEÇ DÖNEM FONKSİYONEL SONUÇLAR VE YAŞAM KALİTESİ: KESİTSEL BİR ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Femur cisim kırığı (FCK) için yapılan internal fiksasyon cerrahilerinde kaynama oranları yüksek olmakla birlikte, yaralanmaların travmatik yapısı nedeniyle oluşan ek sağlık durumları hastaların fonksiyonelliğini ve yaşam kalitesini olumsuz etkileyebilmektedir. Bu kesitsel çalışmanın amacı, izole FCK'larında internal fiksasyon uygulanan genç erişkinlerin geç dönem fonksiyonel sonuçlarını ve yaşam kalitelerini sağlıklı yaşıtlarıyla karşılaştırmaktır.

Yöntem: Çalışmaya 18-55 yaş arasında olan ve internal tespit cerrahisi geçirmiş 20 genç yetişkin gönüllü (ortalama yaş: 39,55±11,92 yıl; ameliyat sonrası süre: 28±7,2 ay) ve benzer yaş ve cinsiyette 20 sağlıklı birey (ortalama yaş: 42,75±8,83) dahil edildi. Katılımcıların fonksiyonelliğini değerlendirmek için Harris Kalça Skoru ve Merdiven Çıkma Testi kullanıldı. Yaşam kalitesini değerlendirmek için EuroQol Yaşam Kalitesi Ölçeği kullanıldı.

Sonuçlar: Cerrahi geçiren bireylerde, kalça fonksiyonelliği ve yaşam kalitesi puanları, sağlıklılara göre daha düşük bulunurken ($p<0.001$); merdiven çıkma test süresi, sağlıklı bireylerden daha uzun bulundu ($p<0.001$).

Tartışma: Bu çalışmanın sonuçları, femur cisim kırığına bağlı internal fiksasyon cerrahisi geçiren bireylerde, 2 yıl sonra bile kalça ile ilişkili fonksiyonel sonuçların ve yaşam kalitesinin sağlıklı akranlarına göre yeterince düzelmediğini performans testlerinde de yetersizlik olduğunu göstermiştir. Cerrahiden sonra uzun dönemde femur cisim kırığına bağlı internal fiksasyon cerrahisi geçiren bireylerde fonksiyonel yetersizliklerin devam etmesi fizyoterapi ve rehabilitasyon uygulamalarının kalçanın fonksiyonel ve yaşam kalitesi ile ilişkili sonuçlarının geliştirilmesi için bireysel ihtiyaçlara göre devam ettirilmesinin gerekli olduğunu düşünüyoruz.

Anahtar Kelimeler: Femoral Kırıklar, Femur, Fonksiyon, Yaşam Kalitesi

INTRODUCTION

Femoral shaft fracture (FSF) is defined as the disruption of the anatomical integrity of the femoral diaphysis, from 5 cm below the trochanter minor up to the proximal part of the adductor tubercle (1). FSF is a severe injury that occurs between 37/100.000 a year (2). Injury is most seen in the young population aged 15-40 years who have been exposed to high-energy trauma such as traffic accidents (80-90%), firearm injuries, and falling from heights. Young adult males have a higher rate of injury than females (3). The primary objective in the treatment of FSF is to restore the anatomical integrity of the extremity and to enable individuals to regain their functions in daily life before the fracture.

Currently, the rate of the union varies between 95-99%, and the rate of infection after internal fixation is less than 1% (4). Although surgical treatment is effective in achieving fracture union, it has been reported that the functional performance of the patients after surgery was decreased due to the high-energy traumatic nature of these injuries and possible additional surgical interventions. In the literature, post-surgical persistent problems such as post-operative residual per-trochanteric pain, stiffness in muscles, and difficulty in climbing stairs are frequently mentioned (5-7). The weakness of the abductor muscles of the hip is the most important trigger of these problems. This weakness may occur due to direct damage of the muscle or damage to the superior gluteal nerve during antegrade nailing (8). Also, the pain in the lower limb is a significant predictor and source of disability (9).

The decrease in functional performance after femoral shaft fractures leads to an increase in the level of social dependence within society with a decrease in quality of life (10). Increased length of hospital stays, prolonged rehabilitation processes, and functional deficiencies may adversely affect the quality of life of the patients as well as socioeconomic problems such as professional education life or delay in return to work. However, it has been shown in previous studies that deep psychosocial influences were observed in individuals in the postoperative period (11). Decreases in the quality of life of individuals with FSF have been reported, even after an average of 55 months after surgery (7).

We hypothesized that the long-term functional outcomes and quality of life in young adults who underwent internal fixation surgery of isolated femoral shaft fracture would be not equal to their healthy peers. This study aimed to compare the long-term functional and quality of life outcomes of the young adults who underwent femoral nailing due to isolated femoral shaft fracture with their healthy peers.

METHODS

Sample Size and Participants

The effect size was calculated as 1.08 according to the data obtained from the pilot study (69.66±13.31, 85±14.93) since no similar studies were found in the literature in our study, in which the primary measurement parameter was determined as the total score of Harris Hip Score. According to these results, it was decided to include 20 individuals for each group in the study, according to the analysis made in the G*Power program, for the study to be 91.6% (alpha = 0.05, bidirectional) power. Twenty patients (15 male, 5 female) aged between 18-55 years who underwent internal fixation (IF) surgery participated. All the isolated fractures were fixed with intramedullary nails following either closed or open reduction in the supine position. Twenty healthy participants (15 male, 5 female) aged between 18-55 years were included in the study as a control group. Additional inclusion criteria were at least 1-year post-surgery and radiologically intact femoral shaft fracture. Individuals at risk for secondary osteoporosis, those who had neurological or systemic disease history, those who had undergone surgery for any pathology in the lower extremity, and those who had a revision or additional surgeries such as additional injuries, spinal column injury, tibia, humerus fractures, and subarachnoid bleeding due to FSF injury were excluded in the study.

Ethical approval was obtained from Hacettepe University Non-Interventional Clinical Research Ethics Committee with the number of GO 18/ 08-13. We carried out our studies on humans in ac-

cordance with the principles of the Declaration of Helsinki. This cross-sectional prospective study was conducted in the Department of Orthopedics and Traumatology of Hacettepe University Hospital, between 01.11.2018 - 01.07.2019. Before the procedure, participants were informed about the study, and an informed consent form was signed by all participants.

Procedure

Surgical procedures performed by an orthopedist with 20 years of surgery experience in Hacettepe University Hospital. During the hospitalization period after surgery, all patients received approximately 7-day inpatient physiotherapy program 2 times per day. This program included: Quadriceps isometric exercises, straight leg raises, and active-assistive and passive range of motion exercises. Partial weight-bearing as tolerated was started for all patients from the postoperative first day via crutches or walkers. Home exercises based on inpatient exercises were also advised to all patients before discharge. None of the patients received additional outpatient physical therapy. However, all patients were called for union and wound healing controls on their first week, 6th week, 3rd month, 6th month, and 1st year. Home exercises were also followed and developed by physiotherapists during these visits. Finally, all patients were contacted in for long-term assessments on average 2 years (18-36 months) following their surgery. All assessments are administered by a 5+ year experienced physiotherapist.

Functional Status Assessment

The pain and functional status of all individuals was assessed by the Harris Hip Score (HHS). The HHS is a valid and reliable questionnaire widely used to evaluate hip and related pathologies (12). It is a 10-item scoring including pain, function, functional activities, and joint range of motion. The severity of pain and its effect on activities were measured while scoring it. The HHS has a maximum score of 100 points. Higher scores indicate that lower risk of hip and related pathologies. Therefore, higher scores might be referred to as better functional outcomes following the interventions and surgeries (13,14). The Turkish version of the Harris Hip Score was used in our study. Turkish translation, validation, and cross-cultural adaptation has been performed by Çelik et al. in 2014 (15).

Functional performance was evaluated by the Stair Climb Test (SCT). The SCT is an easily accessible, convenient, and inexpensive test. It can be used to measure functional performance in neurological diseases, cardiovascular problems, post fractures, and musculoskeletal problems. There is no consensus on the number of steps to be used in the SCT (16). It is recommended in SCT that the step depth is 24-27 cm, and the step height is 16-20 cm (17). When performing the test, it was explained that the individual had to go up and down 9 steps. The step height of the stairs was 20 cm. The patients were asked to go up and down the steps one by one as quickly as possible. Before starting the test, an experiment was performed for the individual to fully understand the test. The patient was allowed to hold on to the handrail only to maintain balance, if possible. The patient was instructed to go up and down 9 steps with the start command, and this time was recorded in seconds.

Health-related Quality of Life Assessment

The quality of life was assessed by the EuroQol 5-Dimension Questionnaire (EQ-5D). The EQ-5D is a valid, reliable, standardized, and general health scale measuring health-related quality of life (HRQoL) (18). The EQ-5D is a scale with a wide perspective that can be used to measure the quality of life in many different disease groups, to determine cost-effectiveness analyses, or even to calculate quality-adjusted life expectancy (19). The scale consists of two parts. The first part, the EQ-5D index scale, consists of 5 dimensions including movement, self-care, usual activities, pain/discomfort, and anxiety/depression. Answers to each dimension have 3 options: no problem, some problem, and major problem. Index value results vary between “-0.59” and “1” points. In the index score function, the value of “0” indicates death, and the value of “1” the state of being completely healthy, while the negative values indicate the state of unconsciousness and bedridden life (20,21). Currently, there are more than 100 official language versions of EQ-5D including the Turkish version, which was obtained from EuroQol (www.euroqol.org) and applied to participants (22).

Legend of Figures

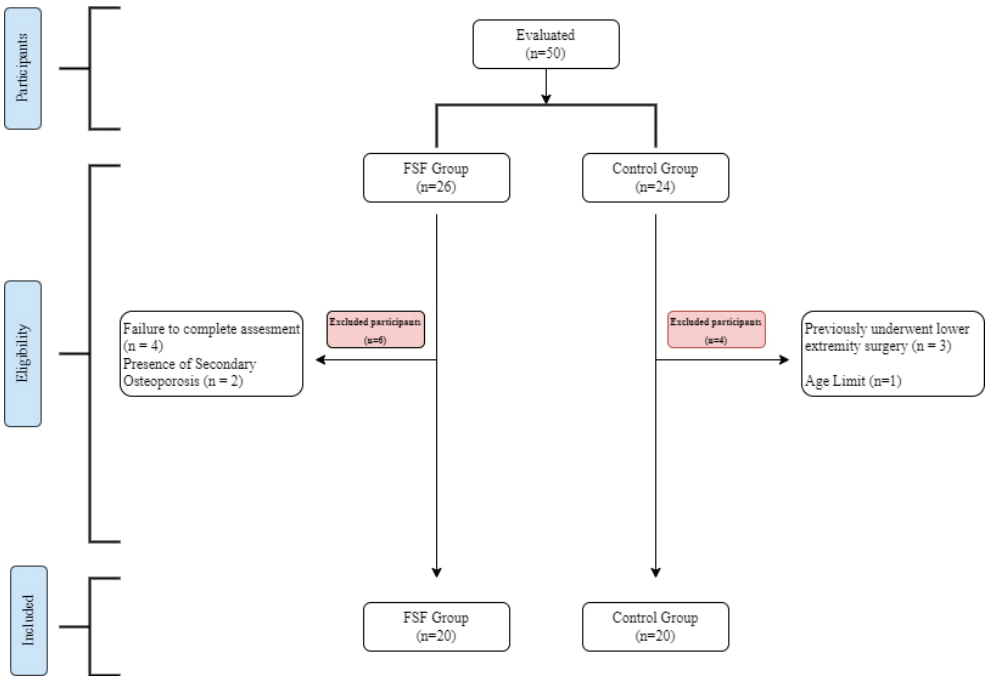

Figure 1. Flow chart of individuals included in the study

Statistical Analysis

Statistical analyses of the study were performed using the "Statistical Package for Social Sciences" (SPSS) version 22.0 (SPSS Inc. Chicago, IL, USA). Visual (probability plots and histograms) and analytical methods (Shapiro-Wilk's/ was performed to determine whether the selected parameters were normally distributed. The Mann-Whitney U-test was used for comparing nonparametric data in independent groups without normal distribution. The level of significance was set at $p<0.05$.

RESULTS

Fifty individuals were included at the beginning of the study. Ten individuals were excluded from the study for various reasons (Figure 1). A total of 40 individuals with "20" in the patient group (39.55±11.92 years) and "20" in the healthy control group (42.75±8.83 years) were included in the present study. The mean postoperative follow-up of the patients (n=20) was 28±7.22 (18-36) months. Their mean length of hospital stay after surgery was 7.35±3.49 (1-14) days.

The most common etiology of fracture was motor vehicle accidents (75%), followed by falls from height (10%), occupational injuries (10%), and firearm injuries (5%).

All the patients underwent antegrade intramedullary nailing in the supine position after closed (80%) or open (20%) reduction. Limb length inequality less than 2 cm was seen in 1 case (5%).

Table 1. Comparison of Physical Characteristics of the Participants

Physical Characteristics (n = 20)	FSF X ± SD	Control X ± SD	t	p
Age (years)	39.55 ± 11.92	42.75 ± 8.83	-0.964	0.43
Height (cm)	170.70 ± 8.51	170.15 ± 8.86	-0.200	0.86
Body weight (kg)	75.45 ± 12.68	74.01 ± 15.03	0.330	0.79
Body Mass Index (kg/m^2)	25.85 ± 3.76	25.40 ± 3.86	0.369	0.82

Independent Samples t-Test, **FSF:** Femoral Shaft Fracture Group, **X ± SD:** Mean ± Standard Deviation

Table 2. Comparison of Functional Performance and Quality of Life Results of Participants

(n=20)	FSF	Control		
	Min.-Max.	Min.-Max.	z	p
HHS	26.8-96.0	79-100	-4.959	<0.001**
SCT (sec)	4.01-29.82	4.20-7.71	-4.355	<0.001**
EQ-5D IS	0.125-0.774	0.596-1.0	-4.915	<0.001**

Mann-Whitney U Test, Min. – **Max**.: Minimum – Maximum, **FSF**: Femoral Shaft Fracture group, **HHS:** Harris Hip Score, **SCT:** Stair Climb Test, **EQ-5D IS:** EuroQol 5-Dimension Index Score

There was no statistically significant difference between the groups in terms of age, sex, height, body weight, and body mass index (p>0.05) (Table 1).

The mean HHS score was 71.65±15.42 in the FSF group, while the mean HHS score was 94.99±5.74 in the control group (p<0.001). For SCT scores, the FSF group (11.5 s) was approximately two times slower than the control group (5.5 s) (p<0.001). The EQ-5D outcomes of the FSF group were also significantly lower than the control group (p<0.001) (Table 2).

DISCUSSION

Functional disability in the early postoperative period is expected in patients with femoral shaft fractures. Our focus with the present study was to examine whether there are still functional deficits in patients in the long-term following union. The results of our study showed that the functional and quality of life outcomes of the individuals with FSF are lower than their healthy peers in the long term after IF surgery.

Evidently, FSF injuries predominantly manifest within the youth adults respectively to high-energy trauma, a trend substantiated by multiple studies with an age range of 30 to 40 years (23-25). Consistent with the studies, the present study has enrolled cases of a mean age of 39.

The incidence of femoral shaft fractures exhibits notable gender-based variations, with a higher prevalence observed among young adult males in comparison to females. In a study conducted by Sonbol et al., they reported a male-to-female ratio of 3.6:1 among the patients included in their investigation (24). Similarly, Elmi et al. indicated a study population distribution where 75% of participants were male and 25% were female. In the present study, it is found that male-to-female ratio of 3:1, which was comparable with literature findings (26).

The Harris Hip Score (HHS) is a frequently used assessment to measure both short- and long-term postoperative functional outcomes in femoral fractures. In the literature, a study in patients who underwent surgery for an intertrochanteric fracture reported a low HHS score in the short term after surgery (27,28). Similarly, in studies conducted in patients operated for proximal femur fracture, it was reported that the HHS score was moderate in the 1-year postoperative period (29,30).

Additionally, Moumni et al. reported that the moderate to severe pain persisted even 7 years after IF surgery after FSF in 17% of the patients and which might be critical source of functional disabilities (9).

Climbing stairs is an important functional performance that is widely used in daily life (31). To climb stairs, increased range of motion of joints and greater muscle strength in the lower extremities are needed. The SCT is an appropriate test of functional performance assessment since stair-climbing activities are both an important part of daily life and are related to independence and participation in society (32). Clinical studies have shown that individuals with osteoarthritis climbed stairs up and down for significantly longer time than individuals of the same age and sex both in the short and long term (17,33). Davis HC et al. demonstrated that lower percent fat mass and higher percent lean mass are individually associated with better physical performance (20-m fast-paced walk, 30-second chair-stand test, stair-climb test) in individuals with radiographic and symptomatic knee OA (33). There is a lack of studies assessing the ability to climb stairs after femoral shaft fracture patients. Our results also indicated disabilities in stair climbing activity in the long term after IF sur-

gery compared to healthy peers. Therefore, the functional performance of individuals with FSF in the short and long term should be monitored in routine clinical visits.

In short-term follow-up clinical studies evaluating the quality of life, it was found that quality of life was significantly lower in both geriatric and young adult populations in injuries such as unstable trochanter fracture and distal femoral fracture, compared to healthy individuals (34,35). Therefore, it is observed that the quality-of-life scores of individuals were lower than the norm values of the EQ-5D population in long-term follow-up studies (10). Ramoutar et al. evaluated young adult patients with proximal femoral fractures at least 2 years after surgery and found that the mean EQ-5D value was 0.70 (36). Larsen et al. reported that the mean value of EQ-5D was 0.79 in young adult patients, which they evaluated on average 55 months after FSF. In our study, the mean EQ-5D value of the patients with femoral shaft fractures was 0.52 and the mean EQ-5D value of the healthy individuals evaluated was 0.84. We think that the reason for some difference between the results of our study and the results of the studies of Ramoutar et al., and Larsen et al. is the difference in the norm values of the population in which the studies were conducted. However, we consider that this numerical difference can be explained by the facts that there is no norm value for the Turkish population in the EQ-5D scales formed by the EuroQol group and that Larsen et al. reported that the mean Danish index was 0.928 for males and 0.903 for females in their comparative study with the norm values of the Danish population (7). Even though the index scores may be different according to cultural norm values, it is reported that the long-term quality of life scores of our individuals with femoral shaft fractures were lower than their healthy peers in the present study.

This study has some limitations. Firstly, the present study did not measure the hip muscle strength of individuals with FSF. Hip muscle strength after surgery may be related to functional outcomes and quality of life. Further studies are necessary to determine whether individuals with FSF have long-term weakness in the hip and related muscles. Second, the preoperative status of functionality and quality of life of the patients could be obtained to compare long-term outcomes with healthy peers. Since the FSF requires immediate surgical intervention, the preoperative status of patients unable to be recorded. Lastly, the cross-sectional design of the present study limits the generalization of the obtained results.

We demonstrated that the individuals with FSF had lower functional outcomes and decreased quality of life even in the long term after internal fixation surgery. It is obvious that only achieving fracture union after surgery does not guarantee long-term better functional outcomes and quality of life. Therefore, the functional outcomes and quality of life assessments should be also on the agenda of health professionals both in the short and long term after surgery to develop better rehabilitation strategies for better outcomes in the FSF population.

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Humeyra KILOATAR, PT, PhD[1]
Meltem ISINTAS, PT, PhD[1]

MANUEL LENF DRENAJI SAĞLIKLI KADINLARDA OTONOMİK FONKSİYONLARI ETKİLER Mİ?: BİR RANDOMİZE KONTROLLÜ ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışma, sağlıklı kadınlarda manuel lenf drenajının (MLD) otonomik fonksiyonlar üzerindeki etkilerini incelemeyi amaçlamaktadır.

Yöntem: 40 sağlıklı kadın çalışmaya dahil edildi. Tek kör randomize kontrollü çalışmada katılımcılar MLD, sham MLD ve kontrol grubu olarak 3 gruba ayrıldı. Katılımcıların demografik bilgileri, kan basıncı ve kalp hızı değişkenliği (KHD) değerlendirildikten sonra soğuk basınç testi uygulandı. Testin hemen ardından kan basıncı ve KHD yeniden değerlendirildi. MLD grubuna MLD uygulamaları yapıldı. Sham MLD grubuna sham protokolü uygulandı. Kontrol grubundan 10 dakika sırt üstü yatmaları istendi. Uygulama sonrası katılımcılar tekrar değerlendirildi.

Sonuçlar: Sistolik kan basıncı soğuk basınç testi ile her 3 grupta da düşerken, sham MLD grubunda uygulama sonrası düşmeye devam etti (p<0,05). Soğuk basınç testi sonrası MLD, sham MLD ve kontrol gruplarında kalp atım hızında anlamlı azalma olurken, uygulama sonrası sadece MLD grubunda anlamlı düşüş devam etti (p<0,05). KHD'nin RMSSD parametresi uygulama sonrası sadece MLD grubunda anlamlı olarak arttı (p<0,05). RR aralığı değeri hem soğuk basınç testi hem de uygulama sonrası MLD ve kontrol gruplarında arttı (p<0,05).

Tartışma: MLD, KHD parametrelerindeki değişiklik nedeniyle parasempatik sinir sisteminin aktivasyonunda kullanılabilir. Parasempatik sinir sistemi aktivasyonu özellikle otonomik etkilenim olan bazı hastalıkların tedavisinde önemli bir tedavi yaklaşımı olabilir.

Anahtar Kelimeler: Kalp hızı değişkenliği, Manuel lenf drenajı, Otonomik fonksiyon, Soğuk basınç testi

DOES MANUAL LYMPH DRAINAGE AFFECT AUTONOMIC FUNCTIONS IN HEALTHY WOMEN?: A RANDOMIZED CONTROLLED STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study aimed to examine the effects of manual lymph drainage (MLD) on autonomic functions in healthy women.

Methods: 40 women were included in the study. In the single-blind randomized controlled study, the participants were divided into 3 groups MLD, sham MLD, and control group. After evaluating the demographic information, blood pressure (BP), and heart rate variability (HRV) of the participants, the cold pressure test was applied. Immediately after the test, BP and HRV were re-evaluated. The MLD group received MLD applications. A sham protocol was applied to the sham MLD group. The control group was asked to lie on their back for 10 minutes. After the application, participants were re-evaluated.

Results: While systolic BP decreased in all 3 groups with the cold pressure test, it continued to decrease after the application in the sham MLD group (p<0.05). While there was a significant decrease in heart rate in the MLD, sham MLD, and control groups after the cold pressure test, a significant decrease continued only in the MLD group after the application (p<0.05). The RMSSD parameter of HRV increased significantly only in the MLD group after the application (p<0.05). The RR interval value increased both after the cold pressure test and after the application in MLD and control groups (p<0.05).

Conclusion: MLD can be used in the activation of parasympathetic nervous system (PNS) due to the change in HRV parameters. PNS activation can be an important therapeutic approach in the treatment of some diseases, especially those with autonomic involvement.

Keywords: Autonomic function, Cold pressure test, Heart rate variability, Manual lymph drainage

1 *Department of Physiotherapy and Rehabilitation, Faculty of Health Science, Kutahya Health Sciences University, Campus of Germiyan, 43100 Kutahya, Türkiye*

Correspondence (İletişim):

Humeyra KILOATAR, PT, PhD 1
Department of Physiotherapy and Rehabilitation, Faculty of Health Science, Kutahya Health Sciences University, Campus of Germiyan, 43100 Kutahya, Türkiye
E-Mail: hkiloatar@gmail.com
ORCID: 0000-0003-4340-3443

Meltem ISINTAS, PT, PhD
E-mail: meltem.isintas@ksbu.edu.tr
ORCID: 0000-0001-8162-9641

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INTRODUCTION

The autonomic nervous system (ANS) is a complex system that includes many areas of both the central and peripheral nervous system and is associated with many organs (1). It is responsible for regulating visceral functions and maintaining homeostasis in the body. Two important parts of the peripheral autonomic nervous system; while the sympathetic nervous system sends 'fight or flight' signals to the body, the parasympathetic nervous system sends the 'rest or digest' signal (2). ANS is evaluated clinically through maneuvers that trigger the autonomic nervous system such as blood pressure, heart rate variability (HRV), valsalva maneuver, or sudomotor autonomic tests (3). HRV is a physiological signal consisting of oscillations in successive intervals of heartbeats controlled by the autonomic nervous system. It is an effective method in the non-invasive evaluation of both the sympathetic and parasympathetic nervous systems (4). Electrocardiography (ECG), a noninvasive method, is used to evaluate cardiovascular autonomic functions. ECG recordings are made in two different ways. The first is the short-term measurements before/after that are made under control in a laboratory environment. Short-term measurements over 5 minutes are standard. The other is the holter measurement made for 24 hours (5). Short-term measurements reflect the relationship between the sympathetic and parasympathetic nervous systems. Long-term measurements reflect change in heart rate with involvement of circadian rhythm, core body temperature, sleep, metabolism, and renin-angiotensin systems (6).

Manual lymph drainage (MLD) is a manual therapy method consisting of low-pressure, slow, repetitive movements that allow the skin to return to its starting position to accelerate and direct lymphatic flow (7). MLD, which is used as a component of complex decongestive therapy in the treatment of lymphedema; can be used in the treatment of many diseases and symptoms such as traumatic injuries, muscle fiber tears, complex regional pain syndrome, scar treatment, rheumatological diseases, headache, migraine, fibromyalgia (8). The mechanism underlying the use of MLD in diseases other than lymphedema treatment; is explained as the effects on the autonomic nervous system, cardiovascular system, and pain (9).

Experimental stress was taken from the field of engineering by Hans Selye in 1936 and defined as a phenomenon that produces a series of interrelated symptoms with various stimuli in biological systems. Stress sources can be physical, psychological, or mixed. The stress-related changes occur at the psychological (emotional and cognitive), behavioral (fight or flight), and physiological (altered autonomic and neuroendocrine function) levels (10). The cold pressure test is frequently used in the evaluation of the autonomic nervous system by creating experimental acute stress. There are different studies in the literature that the cold pressure test, which is a simple, reliable, reproducible, and well-designed test, activates the autonomic nervous system sympathetically or parasympathetically (11).

The results regarding the effects of MLD on ANS are controversial and limited in the literature (9,12–15). The methodological deficiencies and differences in the current studies, the lack of consensus in the results, and the absence of the sham MLD protocol necessitate the need for new studies.

The study aimed to evaluate the effect of experimental stress on the autonomic functions with the cold pressure test applied for 2 minutes and to determine the effects of MLD applied afterward.

METHODS

Study Design

The study was approved by the Ethics Committee of Kutahya Health Sciences University (Protocol No. 2021/03-06) and was conducted at Kutahya Health Sciences University, Department of Physiotherapy and Rehabilitation from June 7, 2021, to July 2, 2022. The manuscript was reported according to CONSORT guideline. 46 participants were included in the study. But 6 participants were excluded from the study because of unwillingness to continue the study and unable to complete the cold pressure test (Figure 1.) . The inclusion criteria for the study were being over 18 years of age and being voluntary to participate in the study. The exclusion criteria were having advanced cardiorespiratory diseases, orthopedic and neurological problems, using medication

related to pain and cardiovascular system, having skin disorders that prevent skin contact, and having cold urticaria. All study procedures were conducted according to the principles of Good Clinical Practice and the Helsinki Declaration. Written informed consent was obtained from all individual participants.

Randomization

This study was planned as a single-blind randomized controlled trial. Randomization was performed using the online computer program (http://www.randomizer.org). The randomization method based on a single sequence of random assignments is known as simple randomization. The participants included in the study were randomly divided into 3 groups; manual lymph drainage, sham manual lymph drainage, and a control group in the computer program. Participants were assigned to groups in a 1:1 ratio. Assignment and randomization were made by the researcher (M.I.A.). The participants were blinded. The content and name of the treatment approach applied to the participants have not been detailed; however, it has been stated that sham MLD and MLD groups will receive a manual treatment approach. Each participant has been individually treated without observing the treatment approach applied to other participants.

Study Protocol

Participants rested for 5 minutes before the first evaluation. The first evaluation was made after the demographic information of the participant was obtained. Within the scope of this evaluation, blood pressure, heart rate, and heart rate variability were evaluated. All assessments were performed on the patient's dominant upper extremity. After the evaluation, cold pressure test was applied to the dominant extremity. A second assessment was made immediately after the test. All of the parameters examined within the scope of the first evaluation were examined for the second time. Appropriate treatment was applied to the group to which the participant belonged. After the treatment, the third evaluation was made and the study was terminat-

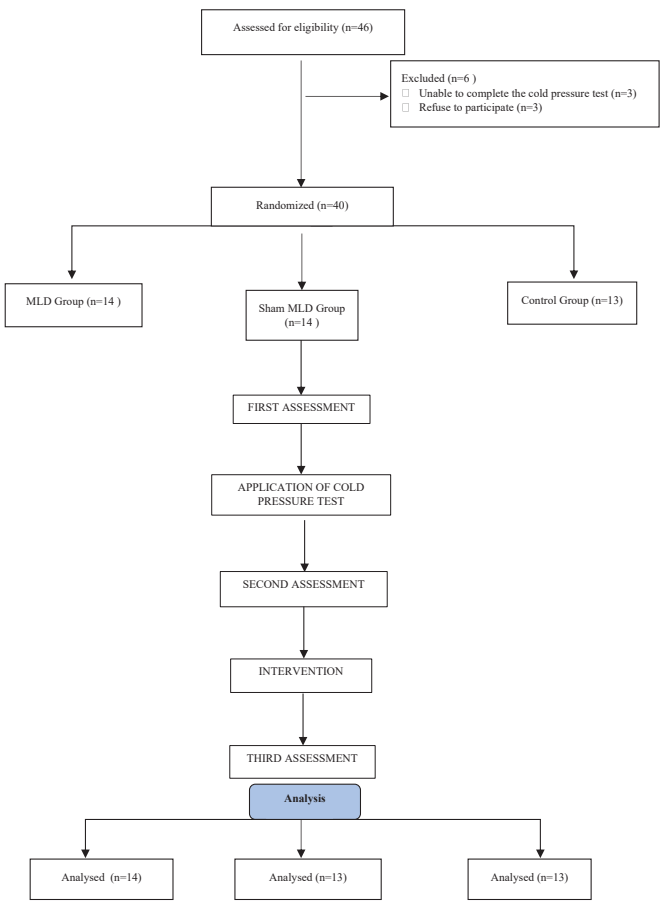

Figure 1. Flow Chart

ed. All participants were asked to avoid exercise, caffeine, energy drinks, and heavy meals at least 1 hour before the test. Environmental noise, light, and temperature were controlled during the test.

Outcome Measures

Demographic information

First, a form prepared by the research physiotherapist was filled out to define the participant's height, body weight, body mass index, age, occupation, smoking, and alcohol use.

Evaluation of Blood Pressure

Blood pressure was evaluated with the Omron® M2 Basic (Omron Healthcare, Kyoto, Japan) brand measuring device (16). A single measurement was made on the dominant arm while the participants were in the sitting position. Systolic blood pressure (SBP) (mmHg) and diastolic blood pressure (DBP) (mmHg) were evaluated.

Evaluation of Heart Rate and Heart Rate Variability

Polar H10 (Polar Electro Oy, Kempele, Finland) heart rate sensor was used to evaluate heart rate and heart rate variability (17). Polar H10 is a heart rate sensor that is placed under the chest with an elastic electrode strap. RR intervals were recorded for 5 minutes with the smartphone app (Elite HRV) (18). The measurement was made with the participant in a sitting position, without any clothing in the area where the device was placed. Heart rate variability was investigated in both time and frequency domains that are heart rate (beats/minute), the standard deviation of NN intervals (SDNN) (ms), the root mean square of successive differences between normal heartbeats (RMSSD) (ms), the proportion of NN50 divided by the total number of NN (PNN50) (%), mean RR interval, total power, LF/HF ratio (Hz), low frequency (LF) (Hz), high frequency (HF) (Hz).

Cold Pressure Test

The test is used to induce experimental stress, induce systemic stress, and evaluate the autonomic nervous system (20–22). In the test protocol; The participant was asked to immerse his dominant hand in water at 4 °C and hold it for 2 minutes. The temperature of the water was monitored with the help of an in-water thermometer. By adding ice cubes, the water temperature was kept constant at 4 °C for 2 minutes. After 2 minutes, he took his hands out of the water and the test was terminated (23,24).

Manual Lymph Drainage

MLD was administered by a certified and experienced physiotherapist (H.K.) trained in the Vodder technique. MLD; neck drainage, abdominal drainage, stimulation of axillary lymph nodes, and right arm drainage were performed by following a special technique and sequence (7). MLD was applied in a comfortable position while the patient was lying in the supine position. It took an average of 20 minutes.

Sham manual lymph drainage

Sham MLD was planned by the same physical therapist as the opposite of MLD techniques. For the Sham MLD protocol, opinions were obtained from 3 physiotherapists who are experts and experienced in the field of complex unloading physiotherapy and 3 physiotherapists working in different fields. Deep pressure was applied from distal to proximal with rapid movements to the right extremity to which the cold pressure test was applied. Fingers, dorsal and palmar surfaces of the hand, forearm, elbow, and upper arm were applied in order. The application was performed while the patient was lying in the supine position and lasted an average of 20 minutes.

Participants in the control group were asked to lie on their backs for 10 minutes without speaking in a quiet, calm environment. At the end of 10 minutes, the patient was placed in a sitting position again and the third evaluation was performed.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS for Windows Version 25.0, USA). Continuous variables were expressed in mean±standard deviation (SD), while categorical variables were stated as numbers and percentages. All variables were assessed for normal distribution using the Kolmogorov–Smirnov. Repeated measures ANOVA was used to evaluate the differences in the mean values of the normally distributed quantitative data. In the absence of

Table 1. The Demographic Comparison in the Groups

		n	Mean±SD	Med	Min	Max	F/KW	p
Age (years)	**MLD**	14	24.14±5.32	22.00	19.00	38.00	KW=1.205	0.547
	Sham MLD	13	25.23±4.71	23.00	20.00	37.00		
	Control	13	24.85±6.11	22.00	19.00	41.00		
Menstrual Cycle Day	**MLD**	14	18.07±7.24	163.50	158.00	170.00	F=1.046	0.361
	Sham MLD	13	13.85±8.48	163.00	150.00	173.00		
	Control	13	15.00±7.91	164.00	154.00	173.00		
Height (cm)	**MLD**	14	163.00±3.90	57.00	49.00	77.00	F=0.033	0.967
	Sham MLD	13	163.54±6.36	62.50	49.00	92.00		
	Control	13	163.23±5.82	65.00	47.00	82.00		
Weight (kg)	**MLD**	14	58.15±7.37	22.30	17.60	30.80	F=1.625	0.212
	Sham MLD	13	64.54±14.04	22.45	18.20	34.70		
	Control	13	65.5±11.59	25.50	16.70	32.50		
Body Mass Index (kg/m2)	**MLD**	14	22.03±3.41	23.20	15.00	36.10	F=1.294	0.287
	Sham MLD	13	24.03±5.00	27.65	15.60	40.90		
	Control	13	24.68±4.6	30.60	11.10	41.50		

n: number of participants; SD: standard deviation; kg: kilogram; cm: centimeter; kg/m^2: kilogram/ square meters; F: one-way analysis of variance; KW: Kruskal Wallis H test; MLD: manual lymph drainage; p: significance level; min: minimum; mak: maximum, med: median

normal distribution, it was analyzed performing the Friedman test. In the normal distribution of data, one-way ANOVA was used for within-group comparations. Kruskal Wallis H test was performed in data without normal distribution. If there were any significant differences in the test of within-group or time effects, post hoc comparisons was performed to determine pairwise differences. p<0.05 was accepted statistical signifance for all measurements.

Sample Size

The power of the study was calculated with the analysis program G*Power (G*Power, version 3.1.9.4 for Windows XP, Germany). According to the power analysis of the Heart Rate score of the 40 participants included in the study, the 95% confi-

Table 2. The Changes in the Blood Pressure Values of the Participants Over Time

			Before Cold Pressure Test[a]	After Cold Pressure Test[b]	After Treatment Protocol[c]	F[1]	p	Post-hoc
		n	**Mean±SD**	**Mean±SD**	**Mean±SD**			
Systolic Blood Pressure (mmHg)	**MLD**	14	114.79±10.03	108.5±7.53	110.64±10.72	4.724	0.018*	a>b
	Sham MLD	13	110.69±7.27	106.15±12.11	100.38±9.03	7.597	0.003*	a>c
	Control	13	116.85±15.65	106.38±12.98	108.62±14.75	7.872	0.002*	a>b
			F=0.969 p=0.389	F=0.187 p=0.830	F=2.852 p=0.070			
Diastolic Blood Pressure (mmHg)	**MLD**	14	73.86±8.17	71.86±9.68	73.21±6.04	0.342	0.714	-
	Sham MLD	13	70.38±11.91	73.31±15.13	70.38±7.19	1.167	0.558	-
	Control	13	70.62±8.67	70.46±8.33	70.46±7.13	0.007	0.993	-
			F=0.549 p=0.582	KW=0.200 p=0.905	F=0.770 p=0.470			

n: number of participants; SD: standard deviation; MLD: manual lymph drainage; F: one-way analysis of variance; F[1]: one way anova for repeated measures; p: significance level; *: p<0,05; min: minimum; mak: maximum, med: median, a: before cold pressure test, b: after cold pressure test, c: after treatment protocol

dence level and the power of the study with 1,706 effect sizes were found to be 99.38% (25).

RESULTS

46 participants were included in the study. But 6 participants were excluded from the study because of unwillingness to continue the study and unable to complete the cold pressure test (Figure 1.). The study was completed with 40 women aged 19-41 years. The age, height, body weight, body mass index, and menstrual cycle day of the women participating in the study are given in Table 1, and there was no statistically significant difference between the groups in terms of these data (p<0.05).

In the MLD and control groups, while systolic blood pressure decreased significantly after the cold pressure test (p<0.05), no significant difference was observed after the application (p>0.05). SBP was significantly reduced after sham MLD application (p<0.05). There was no significant change in DBP either after the cold pressure test or after the applications (p>0.05) (Table 2.).

Table 3. The Changes in the HRV Time Domains

			Before Cold Pressure Test[a]	After Cold Pressure Test[b]	After Treatment Protocol[c]	F[1]	p	Post-hoc
		n	Mean±SD	Mean±SD	Mean±SD			
Heart Rate	MLD	14	86.43±9.09	84±8.94	82.64±8.61	7.740[1]	**0.002***	**a>b,c**
	Sham MLD	13	83.69±7.34	81.54±7.04	81.00±7.06	7.732[1]	**0.003***	**a>c**
	Control	13	87.85±11.01	84.77±6.69	82.69±6.88	8.167[2]	**0.017***	**a>c**
			F=0.676 p=0.515	KW=1.601 p=0.449	F=0.212 p=0.810			
SDNN (ms)	MLD	14	75.9±24.07	74.9±25.79	82.39±24.72	3.431[1]	0.067	----
	Sham MLD	13	93.81±21.33	91.63±24.94	91.2±19.77	0.547[1]	0.586	----
	Control	13	76.49±20.27	81.38±16	78.79±17	3.846[2]	0.146	----
			KW=5.158 p=0.076	F=1.841 p=0.173	F=1.221 p=0.307			
RMSSD (ms)	MLD	14	3.76±0.39	3.75±0.47	3.87±0.39	3.441[1]	**0.047***	**c>b**
	Sham MLD	13	4.07±0.28	4.06±0.34	4.07±0.29	0.086[1]	0.918	----
	Control	13	3.76±0.45	3.87±0.34	3.83±0.33	3.231[2]	0.199	----
			F=2.953 p=0.065	F=2.060 p=0.142	KW=3.788 p=0.150			
PNN50 (%)	MLD	14	21.79±12.95	24.07±15.50	26.57±15.44	3.084	0.063	----
	Sham MLD	13	33.15±12.16	33.54±14.85	33.38±13.11	0.026	0.974	----
	Control	13	22.46±12.25	26.08±12.04	25.00±11.7	1.299	0.291	----
			F=3.448 p=0.042* Post-hoc: 2>1,3	F=1.630 p=0.210	F=1.413 p=0.256			
Mean RR Interval (ms)	MLD	14	711.65±75.19	732.09±78.64	743.71±80.66	**7.334[1]**	**0.011***	**c>a**
	Sham MLD	13	688.02±191.46	754.15±58.29	757.28±61.10	5.922[2]	0.052	----
	Control	13	701.56±84.94	732.17±78.76	739.55±66.1	**6.760[1]**	**0.007***	**c>a**
			KW=0.978 p=0.623	F=0.402 p=0.672	F=0.228 p=0.797			
Total Power (ms^2)	MLD	14	5153.7±3434.18	5213.88±3481.41	5976.18±3781.67	1.465	0.250	----
	Sham MLD	13	7687.52±4725.37	7999.83±4843.93	8056.39±4177.84	0.111	0.895	----
	Control	13	4648.75±2767.1	5625.71±2881.46	4888.47±2273.13	1.436	0.258	----
			F=2.502 p=0.096	F=2.057 p=0.142	F=2.729 p=0.078			

n: number of participants; SD: standard deviation; MLD: manual lymph drainage; F: one-way analysis of variance; F^1: one way anova for repeated measures; KW:Kruskal Wallis H test; SDNN:standard deviation of the NN (R-R) intervals; RMSSD;root mean square of successive RR interval differences; PNN50; proportion of NN50 divided by the total number of NN (R-R); p: significance level; *: p<0,05, a: before cold pressure test, b: after cold pressure test, c: after treatment protocol, [1]:MLD, [2]: Sham MLD, [3]: Control, ms: millisecond, ms^2: millisecond squared

Table 4. The Changes in the HRV Frequency Domains

			Before Cold Pressure Test[a]	After Cold Pressure Test[b]	After Treatment Protocol[c]	F[1]	p	Post-hoc
		n	Mean±SD	Mean±SD	Mean±SD			
LF (ms^2)	MLD	14	4630.64±3272.2	4670.94±3129.8	5385.11±3256.05	1.519	0.241	----
	Sham MLD	13	6866.18±3806.84	6727.56±4418.26	10312.51±13887.07	0.758	0.406	----
	Control	13	4006.3±2430.55	4999.06±2542.43	4363.48±1957.39	6.615	**0.037***	**b>a**
			F=2.846 p=0.071	F=1.363 p=0.268	KW=3.169 p=0.205			
HF (ms^2)	MLD	14	523.06±309.95	543.01±566.09	538.93±622.67	0.143	0.931	----
	Sham MLD	13	1317.81±959.43	1272.27±1019.18	1316.13±1121.45	0.745	0.689	-----
	Control	13	642.52±471.22	626.65±536.64	525.0±417.61	1.077	0.584	----
			KW=8.632 p=0.013* post hoc: 2>1	**KW=6.046 p=0.049* post hoc: 2>1**	**KW=7.351 p=0.025* post hoc: 2>1**			
LF/HF Ratio	MLD	14	10.48±9.01	11.37±9.01	13.25±13.01	2.714	0.257	----
	Sham MLD	13	7.03±3.86	7.75±4.33	7.74±4.80	1.592	0.451	----
	Control	13	9.07±9.41	10.76±5.89	12.58±10.15	8.769	**0.012***	**c>a**
			KW=1.319 p=0.517	F=1.446 P=0.485	KW=2.981 p=0.225			

n: number of participants; SD: standard deviation; MLD: manual lymph drainage; F: one-way analysis of variance; F[1]: one way anova for repeated measures; KW:Kruskal Wallis H test; LF; low frequency, HF; high frequency; p: significance level; *: p<0,05, , a: before cold pressure test, b: after cold pressure test, c: after treatment protocol, [1]:MLD, [2]: Sham MLD, [3]: Control, ms^2: millisecond squared

Heart rate decreased significantly in all groups after the application (p<0.05). RMSSD increased significantly after MLD (p<0.05). The mean RR interval increased statistically significantly in both the control group and the MLD group after the application (p<0.05). No significant differences were found in other variables (p>0.05) (Table 3.).

Considering the change in frequency-dependent HRV parameters, it was found that LF and LF/HF ratios increased significantly in the control group (p<0.05). There was no difference in all groups in the other parameters (p>0.05) (Table 4.).

DISCUSSION

This study aimed to evaluate the effect of experimental stress on autonomic functions with the cold pressure test applied for 2 minutes and to determine the effects of MLD applied afterward and compare it with sham MLD and control application. As a result of the study, in the MLD group with the cold pressure test; SBP and heart rate decreased, in the control group; SBP decreased, and LF increased. After MLD application; heart rate decreased, and RMSSD and mean RR interval increased. In the Sham MLD group; heart rate and SBP decreased. In the control group; heart rate decreased, mean RR interval, and LF/HF ratio increased. However, there was no significant difference between the groups after both the cold pressure test and the applications.

In the current literature, some studies found that the cold pressure test changes the ANS in the direction of both the sympathetic and parasympathetic nervous systems. Mechanisms relating to autonomic nervous system response are largely uncertain. Sympathetic activation increases cholinergic reactions by increasing vascular alpha-adrenergic and cardiac beta-adrenergic responses, causing an active coping strategy. Activating ANS in the parasympathetic direction has a passive coping strategy; it may be to decrease beta-adrenergic responses and increase alpha-adrenergic and cholinergic responses or to respond by increasing cortisol levels through the HPA axis (26). In addition, gender, presence of infection, and anxiety levels also affect the response (27,28). As a result of our study, the cold pressure test revealed different effects in all 3 groups. While the cold pressure test revealed activation in the direction of the parasympathet-

ic nervous system in the MLD and control groups, there was no change in the parameters evaluated concerning the autonomic nervous system in the sham MLD group. Some studies have shown that SARS-CoV-2 infection can cause dysautonomia by affecting the autonomic nervous system in the acute, subacute, and chronic periods (29). In a study evaluating the heart rate variability of COVID-19 patients, an increase in the autonomic nervous system towards the parasympathetic system was observed in the patients. The difference between the groups may be because the data of the study were collected during the pandemic and the effects of the SARS-CoV-2 infection on the participants were unknown. The anxiety level of the participants was unknown. It was also unclear whether the results were affected by this difference between groups.

Several studies dealing with the effects of MLD on HRV have complicated results. A study conducted on healthy men evaluated the effects of MLD on HRV (12). As a result of the study, they found that R-R interval, SDNN, RMSSD, and pNN50 (%) values were higher, and heart rate, LF/HF ratio, and total power were statistically significantly lower in the experimental group. They concluded that MLD changes the autonomic nervous system in the parasympathetic nervous system. In the study, participants were given 2 minutes of psychological stress, but there were no results on how psychological stress changed HRV. In addition, MLD was applied only to the neck and abdomen for 40 minutes. This time is very long only for neck and abdomen MLD applications. Despite these confusing subjects, it was an important study so that we could compare the results of the current study. In a study by Honguten et al., the acute effects of MLD on HRV in healthy volunteers aged 40-65 were evaluated (13). MLD applications were performed by a certified and experienced therapist, in order, to cover the neck, abdomen, and one leg. The control group was only asked to rest. Although there was no difference in HRV parameters as a result of the study, a parasympathetic change was found in the evaluation of the Hoffman reflex in the MLD group.

In our study, MLD parasympathetically activated the autonomic nervous system by decreasing the heart rate and increasing the RMSSD, mean RR interval. The RMSSD means beat-to-beat variance in heart rate and is the primary time measure used to estimate vagal-mediated changes in HRV. An increase in the RMSSD value reflects the activation of the parasympathetic system (6). The mean RR interval is the average of two consecutive R waves in milliseconds. An increase in the mean RR interval indicates activation of the parasympathetic system (5). According to these results, acute MLD can activate the parasympathetic nervous system in healthy women. In addition, there was no significant change in blood pressure after MLD showed that MLD can be used safely in hypertensive individuals. However, considering that our study was conducted in young women, there is a need for studies to be conducted in both different age groups and in men.

This is the first study to compare MLD and sham MLD to the best of our knowledge. We think that testing the sham MLD protocol, which is planned by the researcher as the opposite of MLD principles, will make significant contributions to the literature. A true placebo treatment protocol is not yet available in manual therapy studies. Generally, as a sham protocol, application to a different area or a touch opposite to the application is preferred. It cannot be said that such different touches do not have any effect on health (30). Touch itself can have a positive effect on the body (31). In our study, the sham protocol; affected the autonomic nervous system by causing changes in heart rate and SBP. However, the lack of a study in the literature on which of the parameters evaluating the autonomic nervous system reflects the autonomic activity better and the lack of difference between the groups did not create a clear answer to the superiority of the sham MLD and MLD methods.

In the control group; a decrease in heart rate, mean RR interval, and LF/HF ratio after application suggested parasympathetic system activation. Lying supine may produce a relaxation effect in healthy participants. In future studies, the control group can be applied in a different position.

Limitations

Firstly, the anxiety levels of the participants were not evaluated and their exposure to SARS-CoV-2 infection is unknown. Secondly, this study evaluated the acute effects of a single session of MLD in

healthy volunteers. Lastly, this study was conducted as a single-blind study. Especially in studies with sham protocol, the blindness of the evaluator increases the reliability of the study.

CONCLUSION

To the best of our knowledge, this study is the first to implement the sham MLD protocol. MLD can be used in the activation of the parasympathetic nervous system due to the change in HRV parameters. However, there is a need for new studies to be conducted in different patient populations using the sham MLD protocol. Considering the changes that MLD induces in the autonomic nervous system, it can be used not only as a part of complex decongestive physiotherapy but also as a standalone manual treatment approach in conditions where the autonomic nervous system is affected. However, further studies are needed in patient groups and different age groups. In addition, it should be investigated whether HRV parameters are superior to each other in showing the changes in the autonomic nervous system.

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Ethics Approval: The study was approved by the the Ethical Committee of Kutahya Health Sciences University (Protocol No. 2021/03-06)

Informed Consent: All participants signed an informed consent form.

Author Contributions: Concept-HK, MI; Design-HK, MI; Supervision-MI; Materials-HK; Data Collection and/or Processing-HK; Analysis and/or Interpretation-HK, MI; Literature Research- HK, MI; Writing Manuscript-HK; Critical Review-MI

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Ömer DURSUN PhD, Asst. Prof.[1*]
Cihan ÖNEN PhD, Asst. Prof.[2]

TURKISH RELIABILITY AND VALIDITY OF POSTURAL AWARENESS SCALE IN OFFICE WORKERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study was to perform the Turkish cross-cultural adaptation of the Postural Awareness Scale and test its reliability and validity on office workers.

Methods: The study was conducted at Bitlis Eren University, and 180 office workers were included in the study. The average age of the participants was 39.05±8.44, and 74.4% were male. As a first step, forward and backward translations of the scale were performed. Then, the final version of the scale was developed and introduced to all the participants by face-to-face interviews. The internal consistency and construct validity of the scale was assessed with internal consistency analysis, explanatory and confirmatory analyses.

Results: The Turkish version of the Postural Awareness Scale, consisting of eleven items, had satisfactory reliability (total α score = .854, factor 1 score = .886, factor 2 score = .777). The reliability of the scale was confirmed by the test-retest analysis performed with a two-week interval as well (r = .831). In explanatory factor analysis, twelfth item was loaded on both factors. In confirmatory factor analysis, factor load of the 12th item was low (0.21). For these reasons, the 12th item was removed from the scale.

Conclusion: The Turkish version of the Postural Awareness Scale, consisting of eleven items, is a reliable and valid scale for the assessment of postural awareness in office workers.

Key words: Awareness; Office workers; Posture

POSTÜRAL FARKINDALIK ÖLÇEĞİNİN OFİS ÇALIŞANLARINDA TÜRKÇE GÜVENİRLİK VE GEÇERLİLİĞİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı Postüral Farkındalık Ölçeğinin Türkçe kültürel adaptasyonu ile ofis çalışanlarındaki güvenirlik ve geçerliliğini yapmaktı.

Yöntem: Çalışma Bitlis Eren Üniversitesi'nde yürütüldü ve çalışmaya 180 ofis çalışanı dahil edildi. Çalışmaya dahil edilen katılımcıların yaş ortalamaları 39,05±8,44'tü ve %74,4'ü erkekti. İlk adım olarak ölçeğin ileri geri çevirileri yapıldı. Ardından ölçeğin son hali geliştirildi ve katılımcılara yüz yüze görüşülerek uygulandı. Ölçeğin iç tutarlılığı ve yapısal geçerliliği iç tutarlılık analizi, açıklayıcı ve doğrulayıcı faktör analizleri ile değerlendirildi.

Sonuçlar: On bir maddeden oluşan Postüral Farkındalık Ölçeği Türkçe versiyonu güvenirliği yeterli düzeydeydi (toplam α değeri = .854, faktör 1 = .886, faktör 2 = .777). Ölçek güvenirliği iki hafta arayla yapılan test tekrar testi ile onaylandı (r = .831). Açıklayıcı faktör analizinde on ikinci madde her iki faktöre de yüklenmekteydi. Doğrulayıcı faktör analizinde on ikinci maddenin faktör yükü düşüktü (0.21). Bu sebeplerden dolayı on ikinci madde ölçekten çıkarıldı.

Tartışma: On bir maddeden oluşan Postüral Farkındalık Ölçeği Türkçe versiyonu ofis çalışanlarında postüral farkındalığın değerlendirmesinde güvenilir ve geçerli bir ölçektir.

Anahtar kelimeler: Farkındalık, Ofis çalışanları, Postür

1 *Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bitlis Eren University, Bitlis, Turkey*
2 *Department of Nursing, Faculty of Health Sciences, Bitlis Eren University, Bitlis, Turkey*

Correspondence (İletişim):

Ömer DURSUN
Faculty of Health Sciences, Bitlis Eren University, 13100, Bitlis, Turkey;
e-mail: fztomrdrsn@gmail.com
ORCID: 0000-0002-0522-4228

Cihan ÖNEN
E-mail: cihan_nen@yahoo.com
ORCID ID: 0000-0002-9159-7396

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INTRODUCTION

Posture is the position and alignment of the body parts with respect to each other and has a constantly changing dynamic based on the needs of the individual (1,2). Inherent dynamism in posture has led to the optimal posture concept. Optimal posture is the balance in the musculoskeletal system that prevents injury risk (1). Although optimal posture is explicitly defined for different postures (i.e., sitting posture) (3), considering the modern working conditions, preserving the optimal posture is challenging (4,5). Essentially, office workers drift away from the optimal posture (6).

Office work is one of the types of occupations where aberrations in optimal posture are observed (4). During the office workday sedentary time increases, characterized by prolonged static posture such as sitting (7,8). Workers spend nearly two-thirds of their average daily working time in sitting (9). During sitting, office workers may adopt a fixed malposture characterized by twisting or bending their back (4,6). Malposture among office workers triggers pathological changes in the musculoskeletal system and causes musculoskeletal disorders (4). More than three-quarters of office workers experience musculoskeletal disorders (4), in various body region (10-12). Challenges that office workers face become a socioeconomic burden as well (13).

The socioeconomic burden of the malposture and its effect on office workers yields the importance and necessity of developing prevention or assessment strategies for malposture. Enhancing postural awareness is one of the approaches pointed out in this scope (14). Postural awareness is defined as the subjective conscious awareness of body posture that is mainly based on proprioceptive feedback from the body periphery to the central nervous system (15). Owing to postural awareness, individuals avoid malposture that is risky for them and prevent the development of more harm (15).

Considering the socioeconomic burden of musculoskeletal disorders in office workers and its high prevalence, the relationship between postural awareness and malposture shows the importance and requirement of the assessment of postural awareness, especially for office workers. Due to this requirement, the adaptation of several postural awareness questionnaires to Turkish was performed related to neck (16) and back (17) anatomic regions considering the asymmetric distribution of prevalence and anatomic localization of the musculoskeletal disorders and their symptoms (i.e., pain) (10-12,15). These adapted questionnaires allow clinicians and researchers an opportunity to assess postural awareness in specific body regions. However, since these questionnaires are specific body region-centered, they do not include comprehensive items on global postural awareness and its subcategories (i.e., effortless postural awareness). These factors reveal the necessity of a scale adapted to Turkish that provides a comprehensive assessment of postural awareness. The Postural Awareness Scale (PAS) developed by Cramer et al. (15) is the scale that is exactly developed in that scope. PAS assesses the individuals' familarity with postural awareness and the efforts of individuals to regulate their postural awareness (15). Although the scale was translated into several languages (18-20), the Turkish cross-cultural adaptation of the scale has yet to be performed. From this point of view, the aim of this study was to perform the cross-cultural adaptation of the PAS and test its reliability and validity among office workers.

METHODS

This study was conducted at Bitlis Eren University between November 2022 and April 2023 and approved by the Ethics Committee of Bitlis Eren University (2022/12-5). Prior to enrollment, participants were verbally informed about the study, and their written consent were obtained. Approval of the author, the original developer of the scale, was also obtained. The sample size was calculated based on the number of items in the PAS. It was reported that 5 to 10 participants should be included for each item, and the total number of participants should be greater than 100 (21). A total of 180 office workers (average age = 39.05 years, standard deviation = 8.44 years) were included in the study. The sociodemographic data of the participants was also recorded.

PAS is a scale that assesses an individual's self-reported body posture awareness (15). PAS consists of two factors: ease/familiarity with posture and

need for attention regulation with postural awareness. Each factor consists of six items. Items scored reversely in need for attention regulation with postural awareness factor are the first, second, third, fourth, fifth, and twelfth items. Items are scored from 1 point to 7 points. One point refers to "not at all true for me", and 7 points refer to "very true for me". The total score of the scale ranges from 12 points to 84 points. Higher scores indicate high postural awareness in the individual. The internal consistency of the PAS is reported to be good (total score α = .80, factor 1 = .81, and factor 2 = .77) (15).

As a first stage of cross-cultural adaptation and validation of the original scale, the original scale was translated from German to Turkish by two independent translators. Forward and backward translations were performed to assure adaptation equivalence. The first draft of the scale was acquired after the translations. The first draft was evaluated by a Turkish language expert. The semantic, idiomatic, experiential, conceptual equivalency, and reading level of the first draft were evaluated by the experts committee, consisting of five physiotherapists with PhD degrees. Revisions were performed until all of the experts agreed on the revised scale. In line with the experts' suggestions, the 1st, 4th, 7th, 11th, and 12th items were revised regarding inverted sentence structure, fluency, and comprehensibility. The final version of the scale was developed after a consensus was reached between the experts.

After the final version of the scale was developed, its reliability was evaluated using the internal consistency analysis test-retest method. In the test-retest method scale was performed on 52 office workers with a two-week interval. Internal consistency is determined as poor, moderate, good, or excellent based on the following internal consistency coefficient values; .5, .5-.75, .75-.90, and higher than .90 (22).

Construct validity of the scale was performed with explanatory and confirmatory factor analyses. Explanatory and confirmatory analyses were performed on 180 office workers. Prior to factor analysis, the Kaiser-Mayer-Olkin (KMO) test was performed, and sample relevance was found to be good (.84) (23). Chi square value of the Bartlett Sphericity test was 970.349 (degrees of freedom = 66; p<.001).

Table 1. Sociodemographic Characteristics of the Participants

		n	%	Test	p
Age (years)	21-30	26	14.4		
	31-40	84	46.7		
	41-50	57	31.7	2.374[a]	.072
	>51	13	7.2		
	Average age (years) =39.05, Standard deviation = 8.44				
Gender	Male	134	74.4	1.235[b]	.218
	Female	46	25.6		
Marital status	Single	41	22.8	.162[b]	.872
	Married	139	77.2		
Educational background	≤Bachelor's degree	53	29.4	1.464[b]	.145
	Postgraduate degree	127	70.6		
Income status	Bad	12	6.7		
	Average	49	27.2	.636[a]	.530
	Good	119	66.1		
Working status	Academic staff	123	68.3	1.347[b]	.180
	Administrative staff	57	31.7		

p<.05 statistical significance, [a] one-way ANOVA test, [b] independent samples t test, Age ranges were determined according to the study of Topino et al. (18).

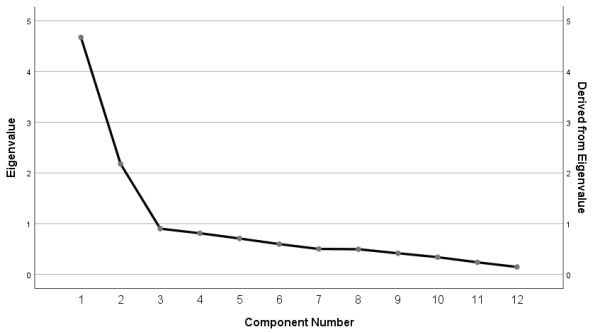

Figure 1. Factor Structure Illustration by Scree Plot Graphic

Statistical analysis

SPSS Amos (IBM, New York, USA) software was used for the confirmatory factor analysis. Explanatory factor analysis was performed by the principal component analysis method to determine PAS's factor structure. In explanatory factor analysis, direct oblimin rotation method was used. Internal consistency and correlation of the scale were assessed with Cronbach's alpha coefficient and Pearson correlation analysis. Kolmogorov-Smirnov test, Skewness, Kurtosis values, and a histogram graphic were used for the assessment of the normal distribution of the scale. Independent sample t test and one-way ANOVA test were used for dual and multiple comparisons. The level of statistical significance was set at p<.05.

RESULTS

Nearly three-quarters of the participants were male, and more than three-quarters of the participants were married. Most of the participants had an associate degree or less. Most of the participants' income was average or good, according to the subjective income classification (24) adapted to the study population and consisting of low, average, good, and very good. The number of academic staff included in the study was two times higher than the number of administrative staff included in the study. There was no statistically significant difference between gender (t = -1.235, p = .218), age (f = 2.374, p = .072), working status (t = -1.347, p = .180) and postural awareness (Table 1). Age range was determined according to the study of Topino et al. (18).

The reliability of the PAS was calculated with internal consistency and test-retest methods. The internal consistency coefficient of the 12 items of the PAS and its factors among the academic and administrative staff working in the university subjected to the research was .834 for the PAS, .886 for factor 1, and .752 for factor 2. Test-retest was performed on 52 office workers with a two-week interval. The reliability coefficient of the test-retest was found to be satisfactory (r = .831). The correlation between each item and the total score was analyzed. In the analysis, the highest correlation was .786 and the lowest correlation was .163. The 12th item had the lowest correlation value (.163).

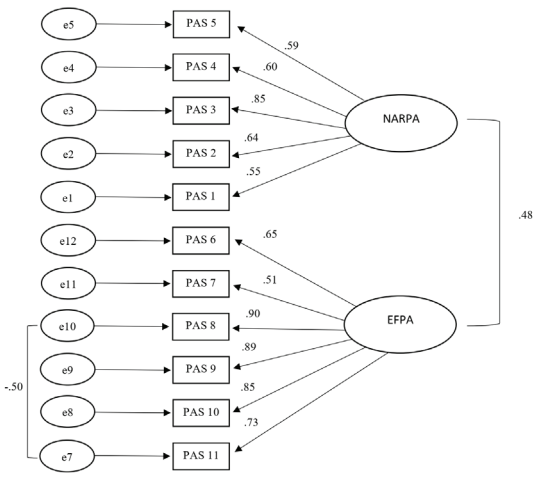

Figure 2. Confirmatory Factor Analysis

Prior to explanatory factor analysis, Kaiser-Mayer-Olkin and Bartlett sphericity tests were performed. The Kaiser-Mayer-Olkin test value was .848, referring to good sample relevance. The chi square value of the Bartlett sphericity test was 970.349±66 (p<.001). Kaiser-Mayer-Olkin and Bartlett Sphericity test results were enough to perform explanatory factor analysis. In explanatory factor analysis, it was observed that the 12th item was loaded on both factors (Table 2). The Scree Plot graphic shows that scale has two factor dimensions (Figure 1). Both factors explain 57.077% of the total variance. The validity of the two-factor dimension and 12 items of the PAS obtained from explanatory factor analysis was analyzed with confirmatory factor analysis. A confirmatory factor analysis was performed for PAS after the explanatory factor analysis. Modifications were performed

Table 2. Explanatory Factor Analysis

		Factor 1	Factor 2
1	Needs to concentrate for being aware of posture		.689
2	Awareness of body posture only by pain		.762
3	Slumps down when sitting		.729
4	Unaware of posture when focused		.657
5	Difficulties to consciously adopt to a posture		.557
6	Often checks posture when working	.739	
7	Influences her/his own appeal by posture	.702	
8	Always aware of sitting or standing posture	.798	
9	Often makes her/himself aware of her/his posture	.864	
10	Aware of posture even when focused	.826	
11	Regulates how she/he feels through posture	.744	
12	Needs to concentrate to feel whether a posture benefits her/him or not	-.375	.553

Factor 1; ease/familiarity with postural awareness, Factor 2; need for attention regulation with postural awareness.

Table 3. Goodness of Fit Indexes of the Confirmatory Factor Analysis

	AGFI	GFI	CFI	NFI	TLI	RMSEA
Recommended range	>.85	>.80	>.90	>.90	>.90	<.08
	.897	.934	.970	.928	.961	.060

AGFI: adjustment goodness of fit index, GFI: goodness of fit statistics, CFI: comparative fit index, RMSEA: root mean square error of approximation, NFI: normal fit index, NNFI, TLI: non-normed fit index

as suggested by the confirmatory factor analysis, and the final model was obtained as illustrated in Figure 2. In the model factor load (regression coefficient) of the 12th item, which falls into the need for attention regulation with postural awareness, it was found to be low (.21). The goodness-of-fit index of the confirmatory analysis was satisfactory (Table 3).

Improvement was observed in the total variance and reliability of PAS after explanatory and confirmatory analyses. The total variance explained rose to 60.13% when the 12th item was removed. Fac-

Table 4. Eleven Item Structure and Factor Load of PAS

		Factor 1	Factor 2
1	Needs to concentrate for being aware of posture		.714
2	Awareness of body posture only by pain		.797
3	Slumps down when sitting		.785
4	Unaware of posture when focused		.675
5	Difficulties to consciously adopt to a posture		.617
6	Often checks posture when working	.730	
7	Influences her/his own appeal by posture	.709	
8	Always aware of sitting or standing posture	.792	
9	Often makes her/himself aware of her/his posture	.870	
10	Aware of posture even when focused	.840	
11	Regulates how she/he feels through posture	.773	

Factor 1; ease/familiarity with postural awareness, Factor 2; need for attention regulation with postural awareness.

tor 1 explains the 42.48%, and factor 2 explains the 17.65% of the variance. In eleven item PAS total score ranges between 11 to 77 points. Average PAS factor scores of the office workers were calculated in this order: 41.54±13.27, 24.76±8.98 (ranging from 6 to 42), and 16.78±6.95 (ranging from 5 to 35) (Table 4).

The reliability and validity of the PAS, consisting of eleven items, were reevaluated after explanatory and confirmatory analyses. Cronbach's alpha coefficient was .854 for all items, .886 for factor 1, and .777 for factor 2. Also, the test-retest score was slightly increased (r = .836).

DISCUSSION

The results of the study revealed that the Turkish version of PAS consists of an 11-item had two-factor structure similar to the original scale developed by Cramer et al. (15) and is a reliable and valid tool to assess postural awareness in office workers. In addition, the results of the study emphasized that sociodemographic parameters (i.e., age and gender) did not affect PAS score.

It is well known that musculoskeletal disorders characterized by chronic pain are seen in office workers, and malposture is regarded as one of the predisposing factors for the development of musculoskeletal disorders in these individuals. Postural awareness of the individual has a definitive role in preventing malposture (15). These facts yield the vital importance of cultural adaptation of a scale to assess postural awareness cumulatively in office workers to develop preventive health measures. PAS is a scale developed in this scope (15).

In the original scale, including 512 participants (92% female, average age = 50.3±11.4) with chronic pain, it was reported that the scale consists of two factors: ease/familiarity with postural awareness and need for attention regulation with postural awareness, and these factors explain 50.80% of the total variance.

An Italian cross-cultural adaptation of the original scale was developed by Topino et al. (20) in a large sample (n = 928, 55% female, mean age = 29.96±11.44) of participants with ages ranging from 18 to 77 years. Like the original scale, Topino et al. (20) found that the scale has two factors: factor 1 explains 27.82% and factor 2 explains 23.18% of the total variance. In total, they report that two factors explain 51% of the total variance. They also report that the scale has good reliability (total PAS = .76, factor 1 = .80, and factor 2 = .79). In the study of Topino et al. (20), 71.55% of the participants were single, almost half of the participants were students; and 44.61% of them had a secondary school degree. The factor load of the 12th item has a low factor load. Similarly, in our study, the factor load of the 12th item was lower.

Another cross-cultural adaptation of the original scale was performed by Colgan et al. (19) in English. They included 301 participants with chronic pain and ages of 18 to 70 years (48% female, mean age = 45±15.5). Similar to the original study (15) and the study of Topino et al. (18) they have found that the scale has good reliability (total PAS = .74, factor 1 = .80, and factor 2 = .81). Similar to the original scale and the study of Topino et al. (20), they found that the scale has two factors, and factor 1 explains 28.82% and factor 2 explains 27% of the total variance. In total, they report that two factors explain 55% of the total variance. Explanatory factor analysis was performed on 150 participants (mean age = 46.59±15.86 years), confirmatory analysis was performed on 151 participants (mean age = 43.70±15.03 years). In the study of Colgan et al. (17) 49% of the participants were married, and 41% of the participants had a high school or lower education degree. In addition, the authors state that the recruitment and data collection processes of the study were performed online due to the COVID-19 pandemic.

The last cross-cultural adaptation of the original scale was performed by Da Costa Silva et al. (18) in French. They included 308 non-clinical adult participants (61.4% female, mean age = 35.22±11.75 years). Similar to the original study (15) and the other cross-cultural adaptation studies (19,20), they have found that the scale has good reliability (total PAS = .70, factor 1 = .82, factor 2 = .77). they discovered, as with the original scale and other studies, that the scale has two factors: factor 1 which explains 26% of the total variance, and factor 2 which explains 12% of the total variance. In total, they report that two factors explain 42% of the total variance. Explanatory factor analysis was

performed on 154 participants (62% female, mean age = 36±12 years), confirmatory analysis was performed on 154 participants (60% female, mean age = 35±12 years). In addition, the authors state that the recruitment and data collection processes for the study were performed online.

In line with the previously reported Turkish version of the PAS, had two factors. The factor load ranged from .553 to .864. However, it was observed that the 12th item of the PAS loading on both factors had a low factor load (.21) in the confirmatory factor analysis. The goodness of fit index values of the confirmatory factor analysis were in an acceptable range (x2 / df = 1.636, AGFI = .897, GFI = .934, CFI = .970, NFI=.928, TLI = .961, RMSEA = .60). It is expected to have a higher correlation between the item scores on the scale and the total score of the scale. It is suggested that the scores of the items should be correlated with the total score of the scale, and correlation values should be higher than .30 (25). Except for the 12th item (r = .163) of the scale, all items had a correlation higher than the minimum acceptable value. The 12th item was removed from the Turkish version of the scale due to breaking the construct validity, which was confirmed by the explanatory and confirmatory factor analyses. The factor load of the final version of the scale ranged from .617 to .870. Thus, the construct validity of the Turkish version of the 11-item PAS was provided.

Although our study differs from the previous studies according to demographic characteristics (i.e., age and gender) and study population, we have achieved similar reliability and validity results. This leads to speculation that these factors may not affect postural awareness. This speculation is confirmed in the study by Topino et al. (20) pointing out that gender and age are not correlated with postural awareness. According to the results of the independent sample t test and one-way ANOVA test, we have concluded the same result for gender (t = 1.235, p = .486) and age (f = 2.374, p = .072) as well. Postural awareness is fundamental for postural control (26), and it is reported to be stable between the ages of 30 and 60 years (27). Because the average age of our participants was in the reference range, age may not affected the PAS score of the participants, as in the study by Topino et al .(20). Although our study was performed in a different population, we reached the same results as the original study, which was performed in individuals with chronic pain. This might be caused by the fact that office workers have a high prevalence of musculoskeletal disorders characterized by chronic pain (28). Calik et al. (29) and Ardahan et al. (30) report that office workers in Turkey have a high incidence of upper back, neck, and lower back pain. Apart from these differences, there was no significant difference between working status and postural awareness. The same working hours and occupational environment might result in this non-significant correlation between working status and postural awareness. Another matter that should be pointed out is the data collection method. Da Costa Silva et al. (18) and Colgan et al. (19) report conducting the study online. In our study, we conducted face-to-face interviews with the participants. However, we have reached the same conclusion as Da Costa Silva et al. (18) and Colgan et al. (19). From this point of view, each method can be used in further studies.

Apart from our study, different Turkish cultural adaptations were performed (16,17) due to the high prevalence of neck and back pain in the society (31,32). In these studies, cultural adaptations of the Fremantle Neck Awareness Questionnaire and the Fremantle Back Awareness Questionnaire are performed by Onan et al. (16) and Erol et al. (17) on patients with chronic neck and back pain. In both studies the reliability and validity of the questionnaire are reported to be good, as Cronbach alpha scores for neck and back awareness are in order by 0.70 (16) and 0.87 (17). In these studies, postural awareness assessment is focused on specific body regions (16,17) because neck and back pain are commonly observed in the population (31,32). In addition, because of the mentioned culturally adapted questionnaires' aim, these questionnaires have only one factor. For this reason, they do not primarily focus on giving clinicians or researchers information about the individual's effortless postural awareness or need for attention regulation with postural awareness, which are the factors of PAS (15). Turkish version of PAS developed in this study by having two factors, and its global postural awareness assessment capability makes it easy to

be implanted in clinical and research settings for the postural awareness assessment in office workers. By the cultural adaptation of PAS, clinicians and researchers are going to have another option to assess postural awareness in office workers in addition to other culturally adapted questionnaires. Clinicians will have an opportunity to assess global postural awareness and compare it with regional postural awareness by the previously culturally adapted questionnaires, and this will aid in developing much more efficient treatment strategies in clinical settings.

In conclusion, the Turkish version of the PAS is a reliable and valid tool for assessing postural awareness in office workers. Turkish version of the PAS can be used for the global postural assessment of office workers and postural awareness subcategories without requiring any equipment.

The study has several limitations. Firstly, additional instrumental methods for the postural assessment were not used in the study. Secondly, chronic pain and its severity was not assessed in participants.

Despite the limitations, this study showed that the Turkish version of the PAS is a reliable and valid non-instrumental assessment method for the postural awareness assessment of office workers. The use of the Turkish version of the PAS on office workers and other individuals in a high-risk group might be beneficial for public health. Determination of adults' postural awareness might contribute to health education planning.

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Rıdvan YILDIZ, PT, PhD[1]
Ali Veysel ÖZDEN, MD, PhD[2]

THE EFFECTS OF TRANSCUTANEOUS AURICULAR VAGUS NERVE STIMULATION ON NERVE CONDUCTION VELOCITY, GRIP STRENGTH, PAIN, AND UPPER EXTREMITY FUNCTIONALITY IN INDIVIDUALS WITH CARPAL TUNNEL SYNDROME

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study aims to investigate the effects of transcutaneous auricular vagus nerve stimulation (taVNS) on key parameters, including nerve conduction velocity, grip strength, pain, and upper extremity functionality in individuals with carpal tunnel syndrome (CTS).

Methods: The study involved 51 patients (90 hands) diagnosed with carpal tunnel syndrome, comprising 12 males and 39 females, ranging in age from 18 to 58 years. Participants were divided into groups by random randomization method. Sensory branch conduction velocity of the median nerve was assessed via electromyography (EMG), hand grip strength was measured using a digital dynamometer, and pain intensity was quantified with a visual analog scale (VAS); additionally, upper extremity functionality was evaluated using the Upper Extremity Functional Index (UEFI) scale before and after the treatment. In the experimental group, in addition to the conventional physiotherapy program, 10 sessions of auricular vagus nerve stimulation were administered; for the sham and control groups, the conventional physiotherapy program alone was conducted over the course of 10 sessions.

Results: The analysis revealed no statistically significant differences between the groups concerning variables such as body mass index (BMI), age, gender, educational background, and smoking status ($p>0.05$). However, within-group evaluations exhibited significant differences compared to baseline values in terms of nerve conduction velocity, pain perception, and upper extremity functionality, with no such difference observed in grip strength ($p<0.05$). The intergroup comparisons indicated a significant difference in favor of the experimental group across all parameters, except for grip strength ($p<0.05$); conversely, no substantial differences were observed between the sham and control groups ($p>0.05$).

Conclusion: The findings suggest that the adjunctive use of taVNS alongside conventional rehabilitation programs in individuals diagnosed with CTS results in increased sensory nerve conduction velocity and enhanced upper extremity functional capacity, accompanied by a reduction in pain; nevertheless, grip strength remains unaffected.

Keywords: Cranial Nerve X, Carpal Tunnel, Nerve Conduction Studies

KARPAL TÜNEL SENDROMU TANILI BİREYLERDE TRANSKÜTANÖZ AURİKÜLER VAGUS SİNİR UYARIMININ SİNİR İLETİ HIZI, KAVRAMA KUVVETİ, AĞRI VE ÜST EKSTREMİTE FONKSİYONELLİĞİNE ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Transkütanöz auriküler vagus uyarımının(taVNS) KTS'de sinir ileti hızı, kavrama kuvveti, ağrı ve üst ekstremite fonksiyonelliği gibi parametrelerdeki etkisinin araştırılması amaçlanmaktadır.

Yöntem: Çalışmaya karpal tünel sendromu tanısı almış, yaşları 18-58 aralığında değişen 51 hasta (90 el) 12 erkek 39 kadın dahil edilmiştir. Katılımcılar, rastgele randomizasyon yöntemi ile gruplara ayrılmışlardır. Tedavi öncesi ve sonrasında olacak şekilde median sinirin duyusal dalının ileti hızını ölçmek amacı ile elektromyografi (EMG) değerlendirmesi, bir dijital dinamometre yardımı ile el kavrama kuvveti, vizüel analog skalası (VAS) ölçeği ile ağrı sorgulaması ve üst ekstremitenin fonksiyonelliğini ölçmek amacı ile üst ekstremite fonksiyonel indeksi (ÜEFİ) ölçeği uygulanmıştır. Çalışmada yer alan deney, sham ve kontrol gruplarına konvansiyonel fizyoterapi programı 10 seans olacak şekilde uygulanırken, deney grubuna konvansiyonel fizyoterapi programıyla birlikte ek olarak 10 seans auriküler vagus sinir uyarımı da gerçekleştirilmiştir.

Sonuçlar: Çalışmada gruplar arasında VKİ, yaş, cinsiyeti eğitim durumu, sigara kullanma durumu gibi parametreler açısından anlamlı farklılıklar bulunmamıştır ($p>0,05$). Grup içi yapılan değerlendirmelerde kavrama kuvveti dışında kalan sinir ileti hızı, ağrı ve üst ekstremite fonksiyonelliği açısından başlangıç durumuna göre anlamlı farklılık bulunmuştur ($p<0,05$). Grupların karşılaştırılması için yapılan analizde ise kavrama kuvveti parametresi dışında kalan tüm parametrelerde deney grubu lehine anlamlı farklılık bulunurken ($p<0,05$), sham ve kontrol grupları arasında anlamlı bir farklılık bulunmamıştır ($p>0,05$).

Tartışma: Çalışma sonucunda KTS tanısı almış bireylerde konvansiyonel rehabilitasyon programına ek olarak uygulanan taVNS'nin duyusal sinir ileti hızını ve üst ekstremite fonksiyonellik seviyesini yükselttiği, ağrıyı azalttığı ancak kavrama kuvveti üzerinde herhangi bir etki oluşturmadığı bulunmuştur.

Anahtar Kelimeler: X. Kranial Sinir, Karpal Tünel, Sinir İleti Çalışmaları

1 *Dicle University/Ataturk Vocational School of Health Sciences/Medical Services and Techniques/ Diyarbakır/Turkey*
2 *Ali Veysel Özden, Bahcesehir University/Faculty of Health Sciences/ Physical therapy and rehabilitation/İstanbul/Turkey*

Correspondence (İletişim):

Rıdvan Yıldız
Dicle University
E-mail: ridvanyildiz2023@gmail.com
ORCID: 0000-0001-8160-1470

Ali Veysel Özden
ORCID:0000-0003-2349-996X

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INTRODUCTION

Peripheral nerves travel alongside various anatomical structures. The interaction between nerves and surrounding structures can lead to nerve compression. This is referred to as 'entrapment neuropathy.' Entrapment neuropathies give rise to symptoms such as pain, numbness, and tingling due to the nerves being impacted. The degree of compression on peripheral nerves can vary. The most prevalent type of entrapment neuropathy is median nerve neuropathy (1).

The median nerve follows a route through a passage formed by the carpal bones and carpal ligament at the wrist level. Changes in this tunnel can result in compression of the median nerve. This condition is known as carpal tunnel syndrome (CTS). Much like other entrapment neuropathies, CTS manifests as symptoms including pain and numbness along the nerve's course (2, 3).

Although the primary cause of CTS remains unclear, several factors are considered to contribute to its manifestation. Generally, three pathoanatomical factors are involved in the emergence of CTS. These factors include elevated pressure within the carpal tunnel, ischemic nerve changes, and compression from adjacent structures (4).

The diagnostic assessment should be comprehensive for CTS diagnosis. This assessment begins with a patient history. It should be followed by an extensive physical examination conducted by specialized physicians. In addition, electrophysiologic tests, imaging modalities, and provocative tests should also be included in the diagnostic assessment (5). Despite these assessments, sensitivity is not 100%. In addition, there is no consensus on which diagnostic criteria are most suitable (2, 6).

Numerous treatment modalities are available for CTS. The choice of treatment differs among individuals. Individual characteristics, the extent of median nerve damage, the accessibility of the treatments to be used, and the efficacy of the selected treatment method are important in developing the treatment plan (7, 8).

The primary objective of treatment methods applicable to CTS is the alleviation of pressure on the median nerve. In this regard, both surgical and conservative treatment approaches are considered. Electrophysiologic parameters play a pivotal role in the classification of treatment methods, with conservative approaches typically recommended for mild and moderately affected individuals, while surgical interventions are usually indicated for advanced and severe CTS cases (9).

Conservative treatment methodologies include splinting, prescribed exercises, medications, electrotherapy, and other physical therapy modalities (10). Notably, non-invasive vagus nerve stimulation, which has gained prominence in recent years, has demonstrated its efficacy in musculoskeletal conditions (11).

Our study postulates that transcutaneous auricular vagus nerve stimulation (taVNS) will result in increased nerve conduction velocity, enhanced grip strength, reduced pain levels, and improved upper extremity functionality among individuals diagnosed with mild to moderate carpal tunnel syndrome.

METHODS

This study employed a randomized controlled clinical research design, utilizing pre- and post-test assessment methodologies. A total of 51 patients, representing 90 hands, all diagnosed with CTS, were included as participants in this study. Before starting the research, ethical approval was obtained from the Ethics Committee for Scientific Research and Publication at Artvin Çoruh University, with approval granted on March 2, 2022, under reference no: E-18457941-050.99-41587. All participating individuals were informed about the research, and their informed consent was obtained through the signing of a "Voluntary Consent Form."

Inclusion Criteria: Aged 18 years or older, voluntarily agreeing to participate in the study., providing informed consent by signing the voluntary consent form., diagnosis of CTS within the mild to moderate classification.

Exclusion criteria: Participants who are unwilling to continue in the study, pregnancy or suspected pregnancy, injuries that could occur during the treatment of the upper or lower extremities, acute wounds or ear infections, exposure to severe trau-

ma affecting the upper extremities and cervical spine during the study, patients who missed treatment sessions.

Study Plan

Power and sample size calculations were conducted using G*Power version 3.1 software (Heinrich Heine University Düsseldorf, Düsseldorf, Germany). To achieve a power of 0.80 with an effect size of 0.80, a total of 75 hands were required for recruitment. Eligible participants were provided with comprehensive explanations regarding the study methods and procedures. Following these explanations, individuals who voluntarily consented to participate and signed the informed consent form were included in the study. Participants were asked to complete a personal information form, which included details about age, gender, body mass index, educational background, smoking status, and dominant hand; subsequently, the participants were randomly assigned to one of three groups. To implement this methodology, three envelopes were provided to participants. Each envelope has a number enclosed. Participants were assigned to one of the three groups based on the number they randomly drew: 1-experiment group, 2-sham group, or 3-control group. The envelope belonging to the group with the completed number of participants was removed and randomization was carried out in this way until the groups were completed. All groups received a 10-session conventional physiotherapy program consisting of transcutaneous electrical nerve stimulation (TENS), ultrasound applications, stretching exercises, and mobilizations. However, the experiment group received an additional ten sessions of taVNS in conjunction with the conventional physiotherapy program, while the sham group underwent sham taVNS application involving the use of headphones for auricular vagus stimulation without the application of current. Adherence to the principles outlined in the Declaration of Helsinki was maintained throughout the study.

Assessment parameters

Demographic information. A questionnaire was administered to gather demographic data from participants, including details such as age, gender, body mass index, educational background, and smoking habits.

Nerve Conduction Velocity Assessment: In accordance with the recommendations of the American Electrodiagnostic Medical Association, EMG is used to diagnose CTS. Standardised electrophysiological parameters for CTS are nerve conduction studies and needle electromyography methods (12, 13). The sensitivity of electrophysiological tests has a range of 56-85% and specificity is over 94%. This has made EMG evaluation a gold standard for the diagnosis of CTS (14). Electromyography was conducted by the same technician in a hospital setting to assess nerve conduction velocity in all participants. During this examination, participants were seated, and electrodes were positioned as required for median nerve measurements. Electroneurophysiological tests were carried out utilizing a 2-channel Alpin-Biomed device. Subsequently, the results were forwarded to a specialist for diagnosis.

Grip Strength Measurement: To measure grip strength, a Cambry dynamometer was used. Participants sat in chairs with their shoulders slightly abducted and in a neutral position, elbows flexed at 90°, and forearms and wrists in a neutral position. Three consecutive tests were performed while participants remained seated. One-minute intervals were allocated between each test. The mean scores of the three measurements were used in statistical analysis (15).

Pain Assessment: Pain levels were evaluated using the Visual Analog Scale (VAS). This scale consists of a 10 cm line, with “0” at one end representing the absence of pain and “10” at the opposite end signifying unbearable pain. Patients were provided with explanations regarding these endpoints and asked to mark the point on the scale that best described their current pain level (16).

Upper Extremity Functional Status Assessment: The Upper Extremity Functional Index (UEFI) was employed to assess the functional status of the upper extremities. The Turkish version of this scale, adapted by Aytar et al., comprises a total of 15 items aimed at measuring functional status. Each item offers five options to gauge the level of difficulty. Participants indicated their most suitable choice and the resulting scores were assessed (17).

Table 1. Comparison of Socio-Demographical Characteristics of Experimental, Sham and Control Groups

		Experimental Group (n:16 patients (30 hands))		Sham Group (n:18 patients (30 hands))		Control Group (n:17 patients (30 hands))		Test Value and Significance
Age	**Mean±SD** **Median (Min-Max)**	47.37±5.82 46.50 (38-58)		47.23±4.95 47 (38-56)		46.70±5.21 47.50 (36-55)		F: 1.12 p: 0.32
BMI	**Mean±SD** **Median (Min-Max)**	32.19±2.35 32.45 (27.30-36.80)		31.22±3.29 31.1 (26.50-36.60)		31.75±2.79 31.10 (26.50-36.80)		x^2: 1.56 p: 0.45
		Number (n)	**Percentage (%)**	**Number (n)**	**Percentage (%)**	**Number (n)**	**Percentage (%)**	
Gender	Male	3	18.75	5	27.77	4	23.52	x^2: .38 p: 0.82
	Female	13	81.25	13	72.23	13	76.48	
Education Level	Primary	9	56.25	10	55.55	10	58,82	x^2: 97 p: 0.98
	Secondary	4	25	5	27.77	4	23.52	
	High school	2	12.50	1	5.55	2	11.76	
	University	1	6.25	2	11.13	1	5.90	
Smoking status	Yes	3	18.75	4	22.22	4	23.52	x^2: .11 p:0 94
	No	13	81.25	14	77.78	13	76.48	

BMI:Body Mass İndex F: One-Way ANOVA Test. x^2: Chi-Square Test

Statistical analysis

Analysis of the data collected was conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). in this study. The normality distribution of the data was assessed with the Shapiro-Wilk test; for the data conforming to a normal distribution, parametric analyses were employed, while non-parametric analyses were used for non-normally distributed data. Within-group comparisons of pre- and post-test results were made using the Wilcoxon Signed Rank Test and Paired Samples t-test; to compare pre- and post-test data between groups, as well as age and BMI values among groups, Kruskal Wallis H and One Way ANOVA analyses were applied. Gender, educational status, and smoking status were compared between groups using Chi-squared analysis (18).

RESULTS

There were no statistically significant differences observed among the groups in terms of mean age, BMI, gender distribution, educational levels, and smoking status (p>0.05) (Table 1).

Table 2. Comparison of Pre-Test and Post-Test EMG, Grip Strength, VAS and UEFI Measurement Results of the Experimental Group

	Mean±SD **Median (Min-Max)**		**z value**	**p value**
	Pre Test (n:16 patients (30 hands)	**Post Test (n:16 patients (30 hands)**		
Sensory Nerve Conduction Velocity (m/s)	41.05±2.75 41.30 (35.4-45.3)	45.64±2.55 45.75 (40.8-49.2)	-4.78	0.00***
VAS	6.33±0.84 6 (5-8)	3.03±0.72 3 (1-4)	-4.83	0.00***
Function (UEFI)	29.40±2.67 30 (24-33)	36.93±0.91 37 (35-38)	-4.79	0.00***
	Mean±SD **Median (Min-Max)**		**t value**	**p value**
	Pre Test (n:16 patients (30 hands)	**Post Test (n:16 patients (30 hands)**		
Grip strength (kg)	28.76±1.64 28.5 (26.10-31.60)	29.30±1.87 29.25 (24.6-31.7)	-1.601	0.10

VAS:Visuel Analog Scale UEFI: Upper Extremity Fonctional İndex z: Wilcoxon Signed Ranks Test. ***p<0.001, z: Paired Samples T Test.

Table 3. Comparison of Pre-Test and Post-Test EMG, Grip Strength, VAS and UEFI Measurement Results of the Sham Group

	Mean±SD Median (Min-Max)		t value	p value
	Pre Test (n:16 patients (30 hands)	**Post Test (n:16 patients (30 hands)**		
Sensory Nerve Conduction Velocity (m/s)	40.40±2.93 40.35 (35.3-45.7)	40.96±3.02 41.40 (34.2-46.9)	-2.575	0.01*
	Mean±SD Median (Min-Max)		**z value**	**p value**
	Pre Test (n:16 patients (30 hands)	**Post Test (n:16 patients (30 hands)**		
Grip strength (kg)	29.03±1.58 28.75 (26.90-31.60)	29.57±1.90 29.25 (26.20-33.20)	-1.34	0.18
VAS	6.10±0.76 6 (5-8)	3.47±0.57 3 (3-5)	-4.89	0.00***
Function (UEFI)	28.97±2.68 29 (24-33)	35.97±1.30 36 (34-38)	-4.79	0.00***

VAS: Visuel Analog Scale z: Paired Samples T Test. *p<0.05, z: Wilcoxon Signed Ranks Test.

Within the experimental group, pre-test and post-test values were analyzed. The results of the analysis indicated a statistically significant difference in EMG findings, which assessed the nerve conduction velocity of the sensory branch of the median nerve, VAS pain scores, and UEFI values, reflecting the functional status of the upper extremity (p<0.05) (Table 2).

Within the sham group, pre-test and post-test values were compared. The results of the analysis indicated a statistically significant difference in EMG findings, which assessed the nerve conduction velocity of the sensory branch of the median nerve, VAS pain scores, and UEFI values, reflecting the functional status of the upper extremity (p<0.05) (Table 3).

Within the control group, pre-test and post-test values were compared. The results of the analysis indicated a statistically significant difference in EMG findings, which assessed the nerve conduction velocity of the sensory branch of the median nerve, VAS pain scores, and UEFI values, reflecting the functional status of the upper extremity (p<0.05) (Table 4).

Upon analyzing the intergroup differences, statistically significant differences were identified among

Table 4. Comparison of Pre-Test and Post-Test EMG, Grip Strength, VAS and UEFI Measurement Results of the Control Group

	Mean±SD Median (Min-Max)		t value	p value
	Pre Test (n:17 patients (30 hands)	**Post Test (n:17 patients (30 hands)**		
Sensory Nerve Conduction Velocity (m/s)	41.40±2.06 41.20 (37.30-45.30)	42.11±2.28 42.55 (35.90-45.70)	-2.326	0.02*
	Mean±SD Median (Min-Max)		**z value**	**p value**
	Pre Test (n:17 patients (30 hands)	**Post Test (n:17 patients (30 hands)**		
Grip strength (kg)	28.68±2.10 28.65 (23.80-31.90)	28.76±2.31 28.70 (21.10-33.10)	-.535	0.59
VAS	6.40±0.86 6 (5-8)	3.43±0.57 3 (2-4)	-4.941	0.00***
Function (UEFI)	28.90±2.55 29 (24-33)	36.13±1.33 36 (34-38)	-4.795	0.00***

VAS:Visuel Analog Scale UEFI: Upper Extremity Fonctional İndex z: Paired Samples T Test. *p<0.05, z: Wilcoxon Signed Ranks Test.

Table 5. Comparison of Pre-Test and Post-Test EMG Measurement Results of Experimental, Sham and Control Groups

		Mean±SD Median (Min-Max)			F/x² value	p value
		Experimental Group (n:16 patients (30 hands))	Sham Group (n:18 patients (30 hands))	Control Group (n:17 patients (30 hands))		
Sensory Nerve Conduction Velocity (m/s)	Pre-Test	41.05±2.75 41.30 (35.40-45.30)	40.40±2.93 40.35 (35.30-45.70)	41.40±2.06 41.20 (37.30-45.30)	1.12F	0.32
	Post Test	45.64±2.55 45.75 (40.80-49.20)	40.96±3.02 41.40 (34.20-46.90)	42.11±2.28 42.55 (35.90-45.70)	32.708x2	0.00***

F: One-Way ANOVA Test. x^2: Kruskal-Wallis H Testi. ***p<0.005

the groups concerning nerve conduction velocity, pain, and upper extremity functionality, whereas no significant differences were observed regarding muscle strength. The difference between the groups is in favour of the experimental group. While the experimental group showed a significant difference compared to the sham and control groups, no significant difference was found between the sham and control groups (Table 5).

DISCUSSION

This study was carried out to investigate the effect of auricular vagus nerve stimulation on nerve conduction velocity, pain, grip strength and upper extremity functionality in individuals diagnosed with carpal tunnel syndrome. The study is one of the first studies in the literature and aims to develop a new treatment method in the clinic.

CTS is characterized by a constellation of symptoms resulting from the compression of the median nerve at the carpal tunnel level. The predominant clinical manifestations include pain, numbness, and tingling (2, 19, 20).

Common symptoms in CTS, such as hand paresthesia and morning pain are primarily attributed to local inflammation and tenosynovitis of the finger flexors, leading to damage of the median nerve. This damage is caused by carpal tunnel stenosis, the anatomical structures surrounding the median nerve, and the considerable mobility of the wrist. These factors lead to prolonged venous stasis, ischemia, and edema, collectively affecting the structure and function of the median nerve and subsequently elevating the pressure within the carpal tunnel (5, 21).

In CTS, edema tends to predominantly affect sensory nerve fibers, while ischemia exerts a greater impact on nociceptive fine fibers. Alterations in wrist positioning can further aggravate inflammation and ischemia within the carpal tunnel. Techniques aimed at alleviating venous stasis and edema, and effectively reducing pressure within the carpal tunnel, are regarded as beneficial maneuvers for addressing this condition (22).

In recent years, the use of taVNS has gained momentum as a therapeutic approach with such effects. The vagus nerve is recognized as a key regulator of the parasympathetic nervous system, an autonomic nervous system division However, it is known as a modulator of inflammation (23, 24). This role is achieved through the release of acetylcholine and its binding to acetylcholine receptors. However, nicotinic receptors have also been identified as influential in controlling systemic inflammation (25). Beyond this, the vagus nerve is also effective in pain modulation. Given these two attributes, vagus nerve stimulation has started to be explored as a novel therapeutic approach with potential applications in conditions such as inflammatory bowel diseases and musculoskeletal disorders (26, 27).

Early studies into the anti-inflammatory potential of vagus nerve stimulation focused on patients with epilepsy. As a result, research demonstrated that VNS contributes to the reduction of serum interleukin-6 (IL-6) levels while elevating the interleukin-10 (IL-10) levels (28, 29). Furthermore, VNS has also been proven to decrease the production of interleukin-8 (IL-8), tumor necrosis factor (TNF), interleukin-1B (IL-1B), and interleukin-6 (IL-6) (24, 30). In addition, vagus nerve stimulation can attenuate neuronal damage through shared cholinergic anti-inflammatory pathways (31, 32).

An investigation was carried out to assess the impact of vagus nerve stimulation on peripheral neuropathies. The study involved the classification of

rats into four distinct groups, namely: control, VNS, sham surgery, and chemotherapy-induced peripheral neuropathy (CIPN). In the CIPN, sham surgery, and VNS groups, rats received intraperitoneal injections of 2 mg/kg paclitaxel on separate days, while the control group was administered saline. On the first day, the sham surgery group underwent a sham surgical procedure. The VNS group, on the other hand, received vagus nerve stimulation, while no interventions were performed on the control and CIPN groups. Various behavioral tests, western blotting assays, and immunohistochemistry assessments were performed throughout the study. The results indicated a significant reduction in withdrawal latency due to paclitaxel treatment. This reduction was more pronounced in the VNS group when compared to the sham surgery group. However, the VNS group displayed no alterations in the expression of nuclear factor-kappa B (NF-κB) or tumor necrosis factor-alpha (TNF-α) compared to untreated rats, while interleukin-10 (IL-10) levels were notably upregulated (33).

In a separate study involving rats, the effects of VNS on neurodegenerative conditions and motor symptoms were examined. The rats were categorized into five groups: control, lesion, lesion+low frequency VNS, lesion+high frequency VNS, and lesion+microburst biomimetic VNS. In the study, daily locomotor activities, forelimb akinesia, the number of TH-positive neurons in the LC-NE system, impacts on the substantia nigra dopaminergic (SN-DA) system, and neuroinflammation were assessed. The findings of the study demonstrated that locomotor activity levels, forelimb akinesia, the number of TH-positive neurons in the LC-NE system, effects on the SN-DA system, and neuroinflammation were restored to baseline values in all groups. However, the groups receiving VNS had more significant improvements compared to the other groups. These results suggest that VNS could effectively impede disease progression by targeting degeneration mechanisms rather than solely addressing symptom management (34).

Conclusion

In our study, we conducted a comparative analysis among the experimental, sham, and control groups to evaluate the efficacy of the intervention under investigation. This analysis revealed a significant difference favoring the experimental group in parameters related to sensory branch nerve conduction velocity, pain levels, and upper extremity functionality; whereas, no significant difference was observed between the sham and control groups. In addition, our comparisons did not reveal any significant difference among the groups concerning grip strength. Upon careful examination of the findings, it becomes evident that individuals diagnosed with CTS experience a notable impact on their upper extremity functionality. This impact can also affect their professional, social, and physical well-being. We propose that the use of taVNS may hold promise in the treatment of these symptoms.

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Authors of this study report no financial interests or connections that might raise the question of bias in the work reported or the conclusions, implications, or opinions stated including pertinent commercial or other sources of funding. *(P.S.: If a conflict of interest exists, it should also be reported.)*

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Yazarlık kriterlerini sağlamayan her katkıdan makalenin "Açıklamalar" bölümünde bahsedilmelidir. Fon sağlamak, veri toplamak, araştırma grubunun genel danışmanlığını yapmak, yazınsal ve teknik düzenleme, dil redaksiyonu ve düzeltmeler tek başına yazarlık hakkı sağlamadığından, "Açıklamalar" bölümünde bahsedilecek başlıklardır.

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Başlık: .....

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KATKI TÜRÜ	AÇIKLAMA	KATKIDA BULUNANLAR
FİKİR/KAVRAM	Araştırma hipotezini veya fikrini oluşturmak	
TASARIM	Sonuçlara ulaşılmasını sağlayacak yöntemi tasarlamak	
DENETLEME/DANIŞMANLIK	Araştırmanın yürütülmesini organize etmek, ilerlemesini gözetmek ve sorumluluğunu almak	
KAYNAKLAR VE FON SAĞLAMA	Çalışma için gerekli personel, mekan, finansal kaynak ve araç-gereçleri sağlamak	
MATERYALLER	Materyaller ile ilgili sorumluluk almak	
VERİ TOPLAMA VE/VEYA VERİ İŞLEME	Verilerin toplanması, düzenlenmesi ve raporlanması için sorumluluk almak	
ANALİZ VE/VEYA YORUMLAMA	Bulguların değerlendirilerek sonuçlandırılmasında sorumluluk almak	
LİTERATÜR TARAMASI	Çalışma için gerekli literatür taramasında sorumluluk almak	
MAKALE YAZIMI	Çalışmanın tamamının veya önemli bölümlerinin yazılmasında sorumluluk almak	
ELEŞTİREL İNCELEME	Çalışmanın raporlanmasından sonra, dil ve yazınsal düzeltmelerden bağımsız olarak bilimsel anlamda çalışmayı yeniden değerlendirmek	

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CONTRIBUTION TYPE	DESCRIPTION	CONTRIBUTORS
CONCEPT	Formulating the research hypothesis or idea	
DESIGN	Designing the method to achieve the results	
SUPERVISION	Organizing the conduct of the research, overseeing its progress, and taking responsibility	
RESOURCES AND FINANCIAL SUPPORT	Providing necessary staff, space, financial resources, and equipment for the study	
MATERIALS	Taking responsibility for the materials	
DATA COLLECTION AND/OR PROCESSING	Taking responsibility for collecting, organizing, and reporting data	
ANALYSIS AND/OR INTERPRETATION	Taking responsibility in evaluating and finalizing the findings	
LITERATURE SEARCH	Taking responsibility in the literature review required for the study	
WRITING MANUSCRIPT	Taking responsibility for the writing of all important parts of the study	
CRITICAL REVIEW	After the report of the study, re-evaluating the study in a scientific sense regardless of language and literary corrections	