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Türkiye Fizyoterapistleri Derneği adına
(On Behalf of Turkish Physiotherapy Association)
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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.

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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.
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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 Aralık sayısında 13 araştırma ve bir sistematik analiz makalesi ile karşınızdayız. Sistematik analiz çalışmasında alet destekli yumuşak doku mobilizasyonunun atletik ve muskuloskeletal durumların yönetimindeki etkinliği, üç araştırma makalesinde ise proprioseptif nöromuskuler fasilitasyon, manuel terapi, pilates ve tüm vücut vibrasyon egzersizlerinin farklı popülasyon ve parametreler üzerine etkileri incelenmiştir. Diğer araştırma makaleleri, serebral palside kaba motor fonksiyon ve aile etkilenimi; kayak, basketbol ve frizbi sporcularında, hemapoietik kök hücre nakli geçiren hastalarda ve kronik venöz yetmezliği olan bireylerde fiziksel ve fonksiyonel durum; kronik bel ağrısı olanlarda psikososyal ve fonksiyonel dinamikler; cinsiyete göre femur boyunun kuadriseps ve hamstring kas fonksiyonu ile ilişkisi ve pediatrik rehabilitasyon ders içeriğinin öğrenci ve mezun bakış açısıyla incelenmesi gibi geniş bir konu yelpazesine sahiptir. Dergimizin bu sayısında ayrıca 7-8 Kasım 2024 tarihlerinde düzenlenen 2. Doğu Karadeniz Fizyoterapi Günleri "Nörorehabilitasyonda Multidisipliner Yaklaşımlar Sempozyumu" ve 19-21 Eylül 2024 tarihlerinde düzenlenen "16. Avrupa Bobath Terapistleri Derneği – EBTA Kongresi" özet bildiri kitapçığını da sizlerle buluşturmanın mutluluğunu yaşıyoruz.

2021 yılı Nisan sayısından bu yana büyük bir onur ve şevkle yürütmekte olduğum Editörlük görevimin sonuna geldiğim bilgisini sizlerle paylaşırken, dört yıllık bu süreçte dergimizin hazırlanmasında büyük emekleri olan hakemlerimize, editörlerimize ve yayın kurulumuza huzurlarınızda teşekkürlerimi sunar, görevi devralacak olan yeni Dergi kurulumuza başarılar dilerim.

Bilime hizmeti ve fizyoterapistlik mesleğinin bilimselliğini arttırmayı ilke edinmiş olan Türk Fizyoterapi ve Rehabilitasyon Dergisinin Editör ekibi olarak 2024 yılının son sayısı ile sizi baş başa bırakırken, yeni yılınızı kutlar, sizlere ve sevdiklerinize huzur, sağlık ve mutluluk dileriz. Bilim ve yenilik dolu bir 2025 yılı dileğiyle...

Yayın Kurulu adına,

Saygılarımla,

Prof. Dr. H Serap İNAL

Baş Editör

EDİTÖRDEN

Dear Readers,

We welcome you with 13 research and one systematic analysis article in the December 2024 issue of the Turkish Journal of Physiotherapy and Rehabilitation.

In the systematic analysis study, the effectiveness of tool-assisted soft tissue mobilization in the management of athletic and musculoskeletal conditions; and in three interventional research articles, the effects of proprioceptive neuromuscular facilitation, manual therapy, Pilates and whole-body vibration exercises on different populations and parameters were examined.

Other research articles include a wide range of assessment topics, such as determinants of gross motor function and family impact in cerebral palsy; physical and functional status in skiing, basketball and frisbee athletes, patients undergoing hematopoietic stem cell transplantation and individuals with chronic venous insufficiency; psychosocial and functional dynamics in patients with chronic low back pain; the relationship of femoral length with quadriceps and hamstring muscle function in men and women, and the pediatric rehabilitation course content from the student and graduate perspective.

In this issue of our journal, we are also happy to present to you the proceedings of the 2nd Eastern Black Sea Physiotherapy Days, "Multidisciplinary Approaches in Neurorehabilitation Symposium" held on 7-8 November 2024 and "16th European Bobath Tutors Association – EBTA Congress" held on 19-21 September 2024.

While I am sharing with you the information that I have come to the end of my Editorial duty, which I have been carrying out with great honor and enthusiasm since the April 2021 issue, I would like to express my gratitude to our referees, editors and editorial board who have contributed greatly to the preparation of our journal during this four-year period, and I wish success to the new Journal board that will take over the task.

As we leave you with the last issue of 2024, as the Editorial team of the Turkish Journal of Physiotherapy and Rehabilitation, which has adopted the principle of serving science and increasing the scientific nature of the physiotherapist profession, we wish you and your loved ones a happy new year full of peace, health and happiness. May the year 2025 full of science and innovations...

On Behalf of the Editorial Board,

Kind Regards,

H. Serap İNAL, PT. Prof.

Editor-in-Chief

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SİSTEMATİK DERLEME (SYSTEMATIC REVIEW)

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PREDICTORS OF GROSS MOTOR FUNCTION LEVEL IN SPASTIC TYPE CEREBRAL PALSY: A RETROSPECTIVE STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study was conducted to identify the determinants of gross motor function in patients with spastic-type Cerebral Palsy (CP) who received physiotherapy from a single center for two years.

Methods: One hundred and eight children with spastic-type CP (mean age: 6.43±4.83 years) were evaluated twice, before and after the two-year physiotherapy. The outcomes were the Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS), Communication Function Classification System (CFCS), and Eating and Drinking Ability Classification System (EDACS). Binary logistic regression analysis was used to determine whether factors such as age, sex, topographical distribution, and levels of GMFCS, MACS, CFCS, and EDACS could predict the improvement in GMFCS level after the two-year physiotherapy.

Results: The odds ratio of improvement in GMFCS level was found to vary significantly with the topographical distribution, CFCS level, and EDACS level ($p<0.05$). Compared to the children with CFCS Level I, children with CFCS Level II, Level III, and Level IV were 0.001, 0.005, and 0.006 times less likely to improve in GMFCS level, respectively. Similarly, children with EDACS Level III and Level IV were respectively 1.605 and 1.548 times less likely to improve in GMFCS level compared to those with Level I.

Conclusion: CFCS and EDACS were significant predictors of gross motor function level in spastic-type CP. Healthcare professionals can use CFCS and EDACS to predict the progression of gross motor function levels, thereby providing more appropriate interventions and more realistic predictions.

Keywords: Cerebral Palsy, Classification, Communication, Eating, Motor Skills

SPASTİK TİP SEREBRAL PALSİDE KABA MOTOR FONKSİYON DÜZEYİNİN BELİRLEYİCİLERİ: RETROSPEKTİF BİR ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışma, iki yıl boyunca tek merkezden fizyoterapi alan spastik tip Serebral Palsi'li (SP) olgularda kaba motor fonksiyonun belirleyicilerini tespit etmek amacıyla yapıldı.

Yöntem: Spastik tip SP'li 108 çocuk (ortalama yaş: 6,43±4,83 yıl), iki yıllık fizyoterapi sürecinin öncesi ve sonrasında toplam iki kez değerlendirildi. Sonuç ölçütleri; Kaba Motor Fonksiyon Sınıflandırma Sistemi (KMFSS), El Becerisi Sınıflandırma Sistemi (EBSS), İletişim Fonksiyon Sınıflandırma Sistemi (İFSS) ve Yeme ve İçme Becerisi Sınıflandırma Sistemi (YİBSS) idi. Yaş, cinsiyet, topografik dağılım ve KMFSS, EBSS, İFSS ve YİBSS düzeyleri gibi faktörlerin iki yıllık fizyoterapiden sonra KMFSS düzeyindeki iyileşmeyi tahmin edip edemeyeceğini belirlemek için ikili lojistik regresyon analizi kullanıldı.

Sonuçlar: KMFSS düzeyindeki iyileşmenin olasılık oranının topografik dağılıma, İFSS düzeyine ve YİBSS düzeyine göre anlamlı düzeyde değiştiği bulundu ($p<0,05$). İFSS Seviye I olan çocuklarla karşılaştırıldığında, İFSS Seviye II, Seviye III ve Seviye IV olan çocukların KMFSS seviyesinde iyileşme olasılığı sırasıyla 0,001, 0,005 ve 0,006 kat daha azdı. Benzer şekilde, YİBSS Seviye III ve Seviye IV olan çocukların KMFSS seviyesinde iyileşme olasılığı Seviye I olanlara göre sırasıyla 1,605 ve 1,548 kat daha azdı.

Tartışma: İFSS ve YİBSS, spastik tip SP'de kaba motor fonksiyon seviyesinin anlamlı belirleyicileriydi. Sağlık uzmanları, kaba motor fonksiyon seviyelerinin ilerleyişini tahmin etmek için İFSS ve YİBSS'yi kullanabilir, böylece daha uygun müdahaleler ve daha gerçekçi tahminler sağlayabilir.

Anahtar Kelimeler: Serebral Palsi, Sınıflandırma, İletişim, Yeme, Motor Beceriler

INTRODUCTION

Cerebral palsy (CP) is one of the most common childhood disabilities, including permanent motor skill disorders secondary to non-progressive brain lesions or anomalies that occur in the developing fetal or infant brain (1). The CP is classified as a spastic, dyskinetic, and ataxic type of CP (2). Children and adolescents with CP exhibit motor impairments and developmental problems, necessitating the evaluation of many developmental areas. A holistic perspective is needed to define health status, including functions such as eating, drinking, manual skills, communication, and ambulation and a multidisciplinary family-centered approach should be given for not only developing physical health but also maintaining a child's quality of life (3,4). Specific classification systems are used to determine the functional states of children and adolescents with CP. For instance, the Gross Motor Function Classification System (GMFCS) identifies gross motor functions; the Manual Ability Classification System (MACS) determines manual skills; the Communication Function Classification System (CFCS) determines communication skills; and the Eating and Drinking Ability Classification System (EDACS) determines eating and drinking abilities in children and adolescents with CP (5–7).

There is currently no practical measurement tool to predict functional development and ambulation in children with CP (8). Using classification systems to identify the present functional level of children and adolescents with CP may help predict functional development. Insights into the altered gross motor functions of children and adolescents with CP are also useful for improving programs to prepare children for adolescence and adulthood (5,9). Knowing early on what the functional prognosis is and what factors might affect maintaining functional ability, healthcare professionals might be able to set more realistic goals. This would help healthcare professionals make better use of treatment resources and design a better treatment plan to keep children and adolescents with CP from losing their functional skills (10).

The progression of motor functions in children and adolescents with CP has been followed only according to age in the previous studies (11,12). However, considering only age may not provide sufficient data. Predicting gross motor function progression in terms of manual abilities, communication skills, and eating and drinking abilities might provide more detailed information. Therefore, the present study aimed to identify the determinants of gross motor function in patients with spastic-type CP who received physiotherapy from a single center for two years.

METHODS

Study Design

This study was carried out in the Düzce Gökkuşağı Special Education Center and the Kdz. Ereğli Gökkuşağı Special Education Center. The data source for this retrospective study was stored medical records from February 2020 to February 2022. The Bolu Abant Izzet Baysal University Clinical Research Ethics Committee provided the ethical approval (approval number: 2022/127, approval date: May 10, 2022) and carried out following the Declaration of Helsinki. Participants were provided with verbal and written descriptions of the study, and parental consent was obtained for each participant. The study was registered on ClinicalTrials.gov with the registration number NCT05505149.

Participants

The child neurology specialist diagnosed CP in all participants, who ranged in age from 3 to 18 years old. For two years, the children and adolescents with CP received services from the Düzce Gökkuşağı Special Education Center and the Kdz. Ereğli Gökkuşağı Special Education Center. The inclusion criteria included having a diagnosis of spastic-type CP and having a parent who is literate in Turkish. The exclusion criteria were: (1) receiving botulinum toxin injection and orthopedic surgery during the study; (2) having a selective dorsal rhizotomy and intrathecal baclofen; and (3) suffering from chronic heart or lung problems.

Sample Size

The G*Power 3.1.9.2 power analysis software was used for the sample size calculation. The calculations were based on an odds ratio of 1.9 (calculated from the pilot study with randomly selected data),

the Pr(Y=1|X=1) H0 of 0.5, an alpha level of 0.05, the desired power of 80%, the R^2 other X of 0, the X parm μ of 0, and the X parm σ of 1 (13,14). Based on these parameters, a sample size of at least 93 was necessary. The study included a total of 108 volunteer children with spastic-type CP.

Assessments

To gather information on sociodemographic and medical variables such as age, gender, clinical type, topographical distribution, surgery and/or botulinum toxin history, and chronic issues, the medical records of eligible children and adolescents with CP were screened. The assessments were conducted in clinical settings at the beginning and two years later by the same researcher, a physical therapist with 10 years of expertise in pediatric rehabilitation (S.A.T.). Throughout the two-year trial period, the participants maintained consistent clinical follow-up.

The GMFCS is a classification system designed to categorize the gross motor functions of children and adolescents with CP, comprising five levels from 1 (most independent) to level 5 (fully dependent) (15). Classifications are based on self-initiated motions, focusing on sitting and walking in daily activities. The Turkish version of the GMFCS demonstrates high test-retest reliability, with an intraclass correlation coefficient (ICC) of 0.94 (16).

The MACS is a classification system designed to categorize the manual abilities of children and adolescents with CP, comprising five levels from 1 (most independent) to level 5 (fully dependent). Classifications are based on the capability to self-manage objects during daily activities. Mini-MACS was used in the present study (17). The Turkish version of the MACS has high test-retest reliability, with an ICC of 0.96 (18).

The CFCS is a classification system designed to categorize the communication abilities of children and adolescents with CP, consisting of five levels ranging from 1 (most independent) to 5 (fully dependent). Classifications are based on the daily performance of all communication methods, including speech, gestures, eye gaze, facial expressions, and augmentative and alternative communication. The

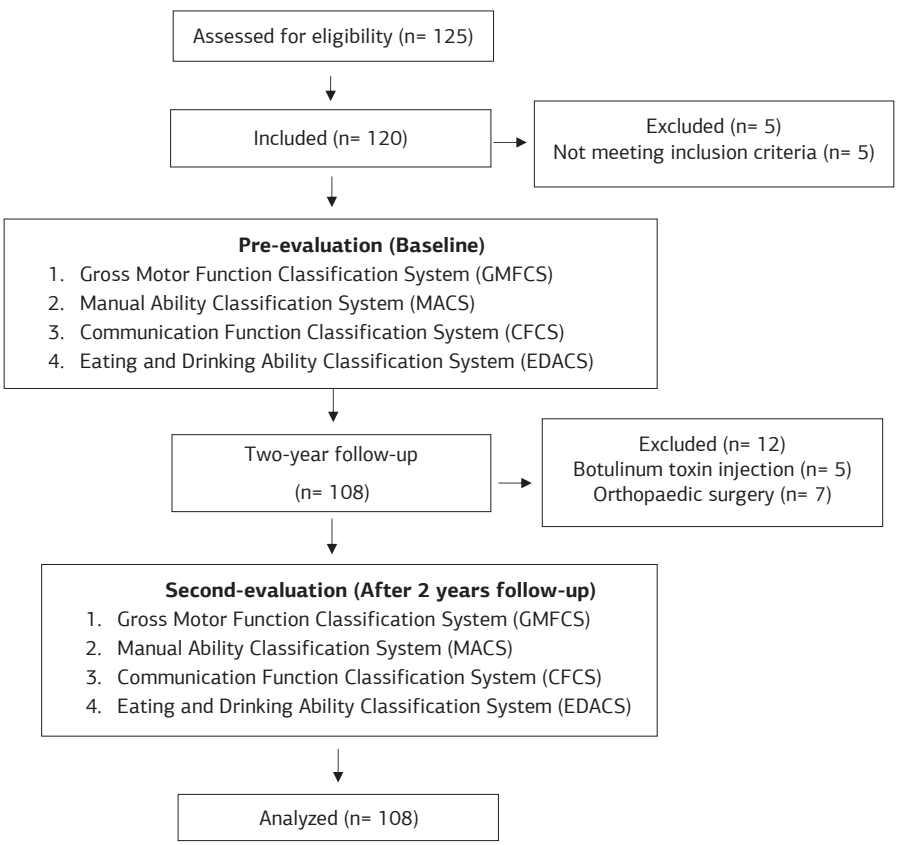

Figure 1. Design of the study

Table 1. Characteristics of Children and Adolescents with CP

Characteristics	Total (3-18 years) N=108	Grup 1 (3-6 years) n=65	Grup 2 (7-12 years) n=29	Grup 3 (13-18 years) n=14
	Number (%)			
Age (yr), Mean±SD	6.43±4.83	3.11±1.74	9.41±1.84	15.64±1.90
Sex				
Girl	45 (41.66)	24 (35.92)	19 (65.51)	2 (14.28)
Boy	63 (58.33)	41 (63.07)	10 (34.48)	12 (85.71)
Type of cerebral palsy				
Quadriparetic spastic-type cerebral palsy	50 (46.29)	36 (55.38)	8 (27.58)	6 (42.86)
Hemiparetic spastic-type cerebral palsy	53 (49.08)	25 (38.46)	21 (72.42)	7 (50.00)
Diparetic spastic-type cerebral palsy	5 (4.63)	4 (6.15)	0 (0)	1 (7.14)
GMFCS				
Level I	44 (40.74)	18 (27.69)	18 (62.06)	8 (57.14)
Level II	12 (11.11)	6 (9.23)	4 (13.79)	2 (14.28)
Level III	12 (11.11)	10 (15.38)	1 (3.44)	1 (7.14)
Level IV	13 (12.03)	9 (13.84)	3 (10.34)	1 (7.14)
Level V	27 (25.00)	22 (33.84)	3 (10.34)	2 (14.28)
MACS				
Level I	15 (13.89)	3 (4.61)	8 (27.58)	4 (28.57)
Level II	39 (36.11)	19 (29.23)	15 (51.72)	5 (35.71)
Level III	25 (23.14)	20 (30.76)	2 (6.89)	3 (21.42)
Level IV	11 (10.19)	8 (12.30)	3 (10.34)	0 (0)
Level V	18 (16.66)	15 (23.07)	1 (3.44)	2 (14.28)
CFCS				
Level I	63 (58.33)	30 (46.15)	21 (72.41)	12 (85.71)
Level II	13 (12.03)	9 (13.84)	4 (13.79)	0 (0)
Level III	6 (5.55)	5 (7.69)	1 (3.44)	0 (0)
Level IV	8 (7.40)	6 (9.23)	2 (6.89)	0 (0)
Level V	18 (16.66)	15 (23.07)	1 (3.44)	2 (14.28)
EDACS				
Level I	56 (51.85)	26 (40.00)	21 (72.41)	9 (64.28)
Level II	23 (21.29)	16 (24.61)	4 (13.79)	3 (21.42)
Level III	13 (12.03)	10 (15.38)	2 (6.89)	1 (7.14)
Level IV	10 (9.25)	7 (10.76)	2 (6.89)	1 (7.14)
Level V	6 (5.55)	6 (9.23)	0 (0)	0 (0)

GMFCS: Gross Motor Function Classification System, MACS: Manual Ability Classification System, CFCS: Communication Function Classification System, EDACS: Eating and Drinking Ability Classification System, SD: Standard Deviation.

Turkish version of the CFCS has high test-retest reliability, with an ICC of 0.82 (19).

The EDACS is a classification system designed to categorize the eating and drinking abilities of children and adolescents with CP, consisting of five levels ranging from 1 (most independent) to 5 (fully dependent). It defines the functional eating and drinking skills of children aged 3 years and older with CP at mealtime (20). The Turkish version of the EDACS has high test-retest reliability, with an ICC of 0.97 (21).

Statistical Analysis

All statistical analyses were conducted with Statistical Package for Social Science (SPSS) version 21.0 for Windows software (SPSS, Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was utilized to test the data distribution before doing the statistical analysis. Descriptive statistics were calculated, including frequency and percentage for categorical variables, and mean and standard deviation for continuous variables. All data were categorized into three age groups: 3-6 (preschool), 7-12 (school age), and 13-18 (adolescence). Binary logistic regression analysis was used to determine whether factors such as age, sex, topographical distribution, and levels of GMFCS, MACS, CFCS, and EDACS could predict the improvement in GMFCS level after two years of physiotherapy. The Enter method was used, and the Hosmer-Lemeshow (H-L) test was conducted to assess the goodness of fit of the fitted logistic regression model. The outcomes

were assessed regarding the model fit statistics and parameter significance, and the significance level was set at p<0.05.

RESULTS

One hundred and twenty-five children with spastic-type CP were assessed for possible eligibility. Seventeen children were excluded for different reasons (Figure 1), leaving a total of 108 (mean age: 6.43±4.83 years, 45 girls). Table 1 presents the demographic and baseline characteristics of the participants. About 46.3% of the children had quadriparetic spastic-type CP, and 49.1% had unilateral spastic-type CP. Most of the children scored GMFCS Level I, MACS Level II, CFCS Level III, and EDACS Level I.

Table 2 demonstrates the levels of GMFCS, MACS, CFCS, and EDACS at baseline and follow-up. None showed deterioration in the level of the GMFCS. A total of 27 children showed an improvement in level, while 81 showed no change. All age groups showed stability in EDACS levels IV and V over a two-year period.

Table 3 shows the results of a logistic regression analysis of the factors that predict an improvement in GMFCS level after treatment. The logistic regression analysis revealed a distinct set of significant predictors for the improvement in GMFCS level. The odds ratio (OR) of improvement in GMFCS level was found to vary significantly with the topographical distribution, CFCS level, and EDACS level (p<0.05). Children with quadriparetic spastic-type CP are 0.011 times less likely to have an improvement in GMFCS level compared to those with hemiparetic spastic-type CP (p=0.033). In addition, compared to children with CFCS Level I, those with Level II, Level III, and Level IV are 0.001, 0.005, and 0.006 times less likely to have an improvement in GMFCS level, respectively (p=0.043, p=0.021, and p=0.012, respectively). Similarly, children with EDACS Level III and Level IV are 1.605 and 1.548 times less likely to have an improvement in GMFCS

Table 2. Levels of GMFCS, MACS, CFCS, and EDACS in Children and Adolescents with CP

Variables	Total (N=108) (3-18 years)		Grup 1 (n=65) (3-6 years)		Grup 2 (n=29) (7-12 years)		Grup 3 (n=14) (13-18 years)	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
	Number (%)		Number (%)		Number (%)		Number (%)	
GMFCS								
Level I	44 (40.74)	54 (50.00)	18 (27.69)	25 (38.46)	18 (62.06)	21 (72.41)	8 (57.14)	8 (57.14)
Level II	12 (11.11)	15 (13.88)	6 (9.23)	11 (16.92)	4 (13.79)	2 (6.89)	2 (14.28)	2 (14.28)
Level III	12 (11.11)	6 (5.55)	10 (15.38)	6 (9.23)	1 (3.44)	0 (0)	1 (7.14)	1 (7.14)
Level IV	13 (12.03)	12 (11.11)	9 (13.84)	7 (10.76)	3 (10.34)	4 (13.79)	1 (7.14)	1 (7.14)
Level V	27 (25.00)	21 (19.44)	22 (33.84)	17 (26.15)	3 (10.34)	2 (6.89)	2 (14.28)	2 (14.28)
MACS								
Level I	15 (13.89)	21 (19.44)	3 (4.61)	6 (9.23)	8 (27.58)	11 (37.93)	4 (28.57)	4 (28.57)
Level II	39 (36.11)	48 (44.44)	19 (29.23)	31 (47.69)	15 (51.72)	12 (41.37)	5 (35.71)	5 (35.71)
Level III	25 (23.14)	16 (14.81)	20 (30.76)	10 (15.38)	2 (6.89)	3 (10.34)	3 (21.42)	3 (21.42)
Level IV	11 (10.19)	6 (5.55)	8 (12.30)	4 (6.15)	3 (10.34)	2 (6.89)	0 (0)	0 (0)
Level V	18 (16.66)	17 (15.74)	15 (23.07)	14 (21.53)	1 (3.44)	1 (3.44)	2 (14.28)	2 (14.28)
CFCS								
Level I	63 (58.33)	74 (68.51)	30 (46.15)	40 (61.53)	21 (72.41)	22 (75.86)	12 (85.71)	12 (85.71)
Level II	13 (12.03)	10 (9.25)	9 (13.84)	6 (9.23)	4 (13.79)	4 (13.79)	0 (0)	0 (0)
Level III	6 (5.55)	2 (1.85)	5 (7.69)	1 (1.53)	1 (3.44)	1 (3.44)	0 (0)	0 (0)
Level IV	8 (7.40)	8 (7.40)	6 (9.23)	7 (10.76)	2 (6.89)	1 (3.44)	0 (0)	0 (0)
Level V	18 (16.66)	14 (12.96)	15 (23.07)	11 (16.92)	1 (3.44)	1 (3.44)	2 (14.28)	2 (14.28)
EDACS								
Level I	56 (51.85)	62 (57.40)	26 (40.00)	32 (49.23)	21 (72.41)	21 (72.41)	9 (64.28)	9 (64.28)
Level II	23 (21.29)	25 (23.14)	16 (24.61)	17 (26.15)	4 (13.79)	5 (17.24)	3 (21.42)	3 (21.42)
Level III	13 (12.03)	5 (4.62)	10 (15.38)	3 (4.61)	2 (6.89)	1 (3.44)	1 (7.14)	1 (7.14)
Level IV	10 (9.25)	10 (9.25)	7 (10.76)	7 (10.76)	2 (6.89)	2 (6.89)	1 (7.14)	1 (7.14)
Level V	6 (5.55)	6 (5.55)	6 (9.23)	6 (9.23)	0 (0)	0 (0)	0 (0)	0 (0)

GMFCS: Gross Motor Function Classification System, MACS: Manual Ability Classification System, CFCS: Communication Function Classification System, EDACS: Eating and Drinking Ability Classification System.

Table 3. Logistic Regression Analysis of Predictors of Improvement in GMFCS Level in Children and Adolescents with CP

Predictor	B	SE	Wald	df	P value	Odds Ratio
Age	0.068	0.131	0.273	1	0.605	1.071
Sex						
Girl[R]						
Boy	-3.100	1.882	2.713	1	0.104	0.045
Type of cerebral palsy						
Quadriparetic spastic-type CP[R]			4.464	2	0.108	
Hemiparetic spastic-type CP	18.333	1.365	0.000	1	0.992	9.161
Diparetic spastic-type CP	-4.400	2.083	4.464	1	***0.033****	0.011
GMFCS						
Level I[R]			4.217	4	0.374	
Level II	-28.512	4.430	0.000	1	0.994	0.001
Level III	-31.674	4.430	0.000	1	0.994	0.001
Level IV	-27.850	4.430	0.000	1	0.994	0.001
Level V	-29.917	4.430	0.000	1	0.994	0.001
MACS						
Level I[R]			0.351	4	0.981	
Level II	-17.756	7.098	0.000	1	0.981	0.001
Level III	-16.758	7.098	0.000	1	0.981	0.001
Level IV	-17.283	7.098	0.000	1	0.981	0.001
Level V	7.811	7.098	0.000	1	0.981	0.001
CFCS						
Level I[R]			7.022	4	0.132	
Level II	-6.844	3.308	4.281	1	***0.043****	0.001
Level III	-5.180	2.242	5.337	1	***0.021****	0.005
Level IV	-12.671	5.337	5.637	1	***0.012****	0.006
Level V	-31.957	1.389	4.875	1	0.994	0.001
EDACS						
Level I[R]			5.186	4	0.269	
Level II	2.818	2.004	1.978	1	0.165	0.743
Level III	9.782	4.631	4.463	1	***0.033****	1.605
Level IV	11.237	5.125	4.808	1	***0.024****	1.548
Level V	28.708	1.544	0.000	1	0.998	0.935
Constant	1.099	0.222	24.441	1	***0.001****	3.000
Goodness of fit	**H-L test**: **x2** = 14.101 p=0.082 **Omnibus test: x2** = 87.870 p<0.001					
R^2 value	**Cox &Snell R^2 =** 0.557					

GMFCS: Gross Motor Function Classification System, MACS: Manual Ability Classification System, CFCS: Communication Function Classification System, EDACS: Eating and Drinking Ability Classification System, * p<0.05, [R] refers to the reference category.

level compared to the children with EDACS Level I, respectively (p=0.033, and p=0.024, respectively). However, age, sex, baseline GMFCS level, and baseline MACS level are not significant predictors of improvement in GMFCS level (p>0.05).

DISCUSSION

The present study aimed to determine the change in the GMFCS, MACS, CFCS, and EDACS levels of children and adolescents with CP and to predict the prognosis of gross motor function level according to the MACS, CFCS, and EDACS over two years. The findings of the present study pointed out that preschool children generally showed greater improvement in GMFCS, MACS, CFCS, and EDACS compared to school-age children. Furthermore, the adolescent period showed no change in all classification systems. Compared to the children with CFCS Level I, children with CFCS Level II, Level III, and Level IV were less likely to improve in GMFCS level. Similarly, children with EDACS Level III and Level IV were less likely to improve in GMFCS level compared to those with Level I. Those with EDACS levels IV and V remained stable for two years in all

age groups.

Various degrees of correlation have been found, ranging from strong to weak, between the levels of GMFCS, MACS, CFCS and EDACS, which are functional classification systems (7,22,23). Only a moderate correlation existed between the CFCS, GMFCS, and MACS (22). Moreover, the prediction of the progression in gross motor function level can be made according to the functional classification systems (6). In the present study, compared to children with CFCS Level I, children with Level II, Level III, and Level IV were found to be less likely to improve at the GMFCS level. Communication skills positively support functional performance and thus might also contribute to the improvement in the GMFCS level (25). In this study, children with EDACS levels III and IV were less likely to improve at the GMFCS level than those with level I. If eating and drinking skills are very good, the development of gross motor function skills is better.

In childhood and adolescence, children also showed stability in EDACS levels IV and V over two years in our study. If eating and drinking skills are poor, this becomes more stable and stabilised after two years. Currently, there is insufficient evidence for longitudinal changes in the eating and drinking skills of children with CP. Sellers et al. evaluated the change in EDACS levels of 97 children with CP at two-year intervals, reporting no change in EDACS levels in 83 children and a level change in 14. Of those fourteen, three showed improvement in EDACS, and ten showed a decline. Considering that these 10 were between the ages of 12 and 19, it reveals a greater decrease in eating and drinking skills in children with CP during adolescence (26), and this statement contradicts our findings. However, in the present study, EDACS levels might have remained stable since all children with CP, especially adolescents had better initial functional levels and continued regular therapy.

Similar to our findings, the previous study reported no alteration in the gross motor function level in school-age children and adolescents with CP over two years (22). Moreover, the GMFCS level remained unchanged for 58.2% of children, the MACS level remained unchanged for 30.3%, and the CFCS level remained unchanged for 39.3% of children with CP under 4 years old. For children under 4 years old with CP, the GMFCS level remains unchanged for 72.3%, the MACS level remains unchanged for 49.1%, and the CFCS level remains unchanged for 55% (6). A recent study concluded that children with CP were more likely to alter their classification level if GMFCS levels were between II and IV, MACS levels were between III and IV, and CFCS levels were between II and V (6). However, the present study included both children with CP and adolescents with CP, and previous reports only reported limited changes in GMFCS levels in adolescent CP (27); therefore, the baseline GMFCS and MACS levels did not predict any change in the present study. On the other hand, it was found that CFCS and EDACS levels could predict gross motor function levels.

Keeratisiroj et al. concluded that positive predictors for ambulation were sitting independently at the age of 2 years and the absence of visual disorder, intellectual disability, and epilepsy (28). The topographical distribution is another factor that plays a role in predicting ambulation in CP. In the present study, topographical distribution, baseline CFCS, and EDACS levels were significant predictors of improvement in GMFCS over two years. In the present study, compared to children with bilateral spastic-type CP, children with unilateral spastic-type CP were less likely to improve on the GMFCS level. In the present study, compared to children with bilateral spastic-type CP, children with unilateral spastic-type CP were less likely to improve on the GMFCS level. In support of our findings, Wu et al. also stated that children with diplegic and hemiplegic CP had better ambulation levels than children with quadriplegic CP (29). However, Schmidt et al. discovered that children with unilateral CP had a lower chance of improving at the GMFCS level than children with other subtypes, and concluded that this was because children with unilateral CP have more stable gross motor function than children with other subtypes (30).

Limitations

To the best of our knowledge, there is only one previous study evaluating the stability of EDACS (31), and it did not evaluate other functional classification systems in addition to the EDACS over

an extended period. The present study has some limitations that should be emphasized. First, the study only included spastic-type CP. Therefore, the findings may not accurately reflect the overall CP population, even though they provide a clearer prediction about the progression of a specific type. Second, there was a long interval between the two evaluations with no intermediate measurements. However, the classification was made by the same therapist in both periods, and this is one of the strengths of our study, because a new evaluator may provide a higher level of function scores than one who has been working with the child for a long time (32). Finally, the present study only used function classification systems as outcome measures and did not evaluate factors such as children's cognitive level, family interest, and motivation.

CONCLUSION

This study found that the topographical distribution of CP, levels of CFCS, and EDACS are significant predictors of the GMFCS level over two years. Knowing the prognosis of function in children with CP might help to establish realistic and achievable goals specific to the children and to develop interventions to improve outcomes for children with different functional levels. Because functional classification systems are the best way to describe children and adolescents with CP, healthcare professionals can use CFCS and EDACS to predict the progression of gross motor function, thereby providing more appropriate interventions and more realistic predictions. There is a need for further studies with a larger sample size, including individuals with CP of all ages and clinical types, and a longer follow-up period.

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DOES THE PRESENCE OF ANEMIA HAVE AN IMPACT ON PHYSICAL FUNCTIONS IN PATIENTS TREATED WITH HEMATOPOIETIC STEM CELL TRANSPLANTATION?

ORIGINAL ARTICLE

ABSTRACT

Purpose: Anemia is an independent factor that may influence physical functions in patients with hematological malignancy. The aim of this study was to determine the impact of anemia on physical functions in patients with hematopoietic stem cell transplantation (HSCT).

Methods: A total of 82 patients with HSCT were retrospectively analyzed. The presence of anemia was determined in accordance with the WHO standard. Fatigue, hand grip and peripheral muscle strength, functional performance, and activities of daily living (ADL) were compared between patients with and without anemia. Additionally, impact of transplantation type and duration since HSCT on the results were analyzed.

Results: Patients with anemia had significantly poorer quadriceps femoris muscle strength, functional performance, and ADL level than patients without anemia (p=0.025, p=0.001, and p=0.009, respectively). Additionally, the duration since HSCT were adjusted in two groups, there was still significant difference in functional performance and ADL between patients with and without anemia (p<0.05).

Conclusion: The presence of anemia in patients with HSCT have negative impact on muscle strength, functional performance, and ADL level. Health care professionals should be aware that patients with anemia may have functional problems.

Keywords: Anemia, functional performance, hematopoietic stem cell transplantation, physical function

HEMATOPOİETİK KÖK HÜCRE NAKLİ OLAN HASTALARDA ANEMİ VARLIĞININ FİZİKSEL FONKSİYONLAR ÜZERİNE ETKİSİ VAR MIDIR?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Anemi, hematolojik malignitesi olan hastalarda fiziksel fonksiyonları etkileyebilen bağımsız bir faktördür. Bu çalışmada, hematopoietik kök hücre nakli (HKHN) ile tedavi edilen hastalarda aneminin fiziksel fonksiyonlar üzerine etkisinin belirlenmesi amaçlandı.

Yöntem: HKHN ile tedavi edilen toplam 82 hasta retrospektif olarak analiz edildi. Anemi varlığı, WHO standardına göre belirlendi. Yorgunluk, el kavrama ve periferik kas kuvveti, fonksiyonel performans ve günlük yaşam aktiviteleri (GYA) anemisi olan ve olmayan hastalar arasında karşılaştırıldı. Ek olarak, transplantasyon tipi ve HKHN'den bu yana geçen sürenin sonuçlar üzerindeki etkisi analiz edildi.

Sonuçlar: Anemisi olan hastalarda kuadriseps femoris kas kuvveti, fonksiyonel performans ve GYA düzeyi anemisi olmayan hastalara göre anlamlı olarak daha düşüktü (sırasıyla p=0,025, p=0,001 ve p=0,009). Ayrıca, HKHN'den bu yana geçen süre her iki grupta kontrol edildiğinde, anemi olan ve olmayan hastalar arasında fonksiyonel performans ve GYA'da hala anlamlı fark vardı (p<0.05).

Tartışma: HKHN ile tedavi edilen hastalarda anemi varlığının kas kuvveti, fonksiyonel performans ve GYA düzeyi üzerinde olumsuz pek çok etkileri vardır. Sağlık profesyonelleri, anemili hastaların fonksiyonel sorunları olabileceğinin farkında olmalıdır.

Anahtar Kelimeler: Anemi, fonksiyonel performans, hematopoietik kök hücre nakli, fiziksel fonksiyon

INTRODUCTION

Hematopoietic stem cell transplantation (HSCT) has been widely using as a treatment option for malign or non-malign hematologic diseases (1). Various disease- and/or treatment-related side effects have been occurred in patients treated with HSCT (2). Anemia is one of the most prevalent clinical symptoms in patients (3). Low hemoglobin level is a symptom of the hematological disease and it is also derived from chemotherapy-related bone marrow suppression. Anemia has been seen in majority of patients undergoing HSCT at any stage of the treatment protocol (4,5).

Anemia leads to decreased oxygen-carrying capacity of blood to muscles and the other organs which is associated with decreased exercise capacity (6). For this reason, its' association with the physical functions have been investigated in several populations in the literature. These studies conducted on cancer patients (7), community-dwelling people (8), geriatric population (9), and other disease groups (10,11). Deterioration of activities of daily living (ADL), functional capacity, quality of life level, and increase in fatigue, anxiety, and depression level have been showed in people with low hemoglobin level (6-12). Anemia has been found as an important factor that influenced muscle strength in patients with hematological malignancy (12).

Decrease in cardiopulmonary fitness level between pre- and post-HSCT was associated with decrease in hemoglobin level in patients treated with allogeneic HSCT (13). To our knowledge, there is no study which investigated the effect of low hemoglobin on physical functions in patients treated with HSCT. Since both HSCT and HSCT-related anemia are highly prevalent in this patient population (4,5), there is need to assess anemia-related physical dysfunctions. Hence, this study aimed to compare fatigue level, muscle strength, functional performance, and independency in ADL between patients with and without HSCT-related anemia.

METHODS

The present study was conducted at Hacettepe University in Turkey. Patients treated with HSCT and referred to physical therapy and rehabilitation service at Hacettepe University between January 2016 and January 2020 were included. The medical records and the physical assessment results were retrospectively analyzed; therefore, no informed consent forms were obtained from the participants. Inclusion criteria for the study were being: (a) between 18 and 65 years old, (b) treated with HSCT at least 3 months ago, (c) able to cooperate, (d) evaluated for physical functions. Exclusion criteria were: (a) having severe orthopedic, neurologic, cardiovascular, and/or mental disease, (b) being diagnosed with graft-versus host disease. The Hacettepe University University Non-Interventional Ethical Committee approved the study protocol (GO 20/703).

Recorded Variables

Demographic and medical characteristics

Participants' demographic data consisted of gender, age, body mass index, educational level, and marital status were recorded. Medical data including diagnosis, duration since diagnosis, comorbidities, type of HSCT, duration since HSCT, and HSCT-related complications were collected. Additionally, hemoglobin levels of the participants were recorded from the hospital records. The presence of the anemia was determined in accordance with the World Health Organization (WHO) standard; anemia was defined in males and females with hemoglobin level under 13 gr/dl and 12 gr/dl, respectively (14).

Fatigue level

Fatigue level was assessed using Visual Analogue Scale (VAS). Fatigue severity was assessed between 0 points (not at all tired) and 10 points (extremely tired) during resting and activity (15).

Handgrip strength

Handgrip strength of the participants was assessed using a standard Jamar hydraulic hand dynamometer (JA Preston Corporation, Clifton, NJ, USA). The test was performed on the dominant hand of the participants in accordance with the American Society of Hand Therapists Guidelines. The mean value of three trials was recorded (16,17).

Peripheral muscle strength

A digital hand-held dynamometer (J-TECH, Medical Commander PowerTrack II, USA) was used to measure peripheral muscle strength. Testing was performed in accordance with the statements of Bohannon and the manufacturer's manual. Shoulder flexors, elbow flexors, knee extensors, and hip flexors muscle strength was measured. Participants were allowed to make three trials for dominant side and the mean value was recorded (18).

Functional performance

The 30-second sit to stand test (30-s SST), which is an indicator of lower body strength and endurance capacity, was used to measure functional performance. The number of stands from sitting position in a chair during a 30-second period was recorded. (19).

Activities of daily life

The Turkish version of the Barthel Index (BI), which is a reliable and valid tool was used to measure

Table 1. Demographic and Medical Characteristics of the Participants (n=82)

	Group 1 (n=40) Median (Min-Max)	Group 2 (n=42) Median (Min-Max)	z/chi-square	p
Age, years	51.00 (21.00-60.00)	43.00 (19.00-62.00)	-1.478	0.139*
Body mass index, kg/m^2	25.15 (15.27-42.60)	27.38 (18.95-35.50)	-0.085	0.932*
Duration since HSCT, month	15.00 (5.00-84.00)	29.00 (6.00-96.00)	-4.684	**0.001***
Hemoglobin level, gr/dl	10.90 (6.10-12.00)	13.60 (12.00-16.20)	-7.205	**0.000***
Gender, n (%)				
Female	19 (47.50)	22 (52.30)	0.195	0.659**
Male	21 (52.50)	20 (47.60)		
Diagnosis, n (%)				
Lymphoma	14 (35.00)	12 (28.50)		
Leukemia	13 (32.50)	18 (42.80)	2.052	0.842**
Multiple myeloma	11 (27.50)	9 (21.40)		
Myelodysplastic syndrome	2 (5.00)	3 (7.10)		
Marital status, n (%)				
Married	33 (82.50)	35 (83.30)	0.002	0.962**
Single	7 (17.50)	7 (16.60)		
Education level, n (%)				
Illiterate	2 (5.00)	2 (4.80)		
Elementary school	13(32.50)	15 (35.70)		
Secondary school	4 (10.00)	4 (9.50)	1.279	0.937**
High school	8 (20.00)	8 (19.00)		
Graduate	12 (30.00)	12 (28.60)		
Postgraduate	1 (2.50)	1 (2.40)		
Transplantation type, n (%)				
Autologous	27 (67.50)	20 (47.60)	3.310	0.069**
Allogeneic	13 (32.50)	22 (52.40)		
The presence of comorbidity				
Yes	5 (12.50)	5 (11.90)	0.031	0.860**
No	35 (87.50)	37 (88.09)		
Comorbidities				
Diabetes mellitus	3	2		
Hypertension	2	1		
Asthma	-	2		
HSCT-related complication				
Yes	4 (10.00)	9 (21.42)	1.677	0.195
No	36 (90.00)	33 (78.57)		
HSCT-related complications				
Cataract	2	3		
Diabetes mellitus	1	1		
Venoocclusive disease	1	-		
Dry eye	-	3		
Infection	-	2		

HSCT: Hematopoietic stem cell transplantation, *Mann-Whitney U test, **Chi-Square test, p<0.05

functionality level in activities of daily life (ADL) (21). The BI consisted of 10 items that measures different aspects of ADL including nutrition, bathing, personal care, dressing, toilet use, mobility on flat surfaces (immobile, wheelchair use, assisted or independent walking), transfer (wheelchair to bed and reverse), stair climbing, bowel, and bladder continence. The total score ranged from 0 (full dependence) to 100 points (full independence) (20).

Statistical analysis

The IBM SPSS 23.0 software (SPSS Inc., Chicago, IL, USA) was used to perform statistical analyses. The results were presented as number and percentages (n, %) or Mean ± Standard Deviation. The statistical significance level was determined as $p<0.05$. Participants were divided in to two groups according to the WHO standard described in the methods (14): Group 1 (patients with anemia), and Group 2 (patients without anemia). The normality assumption was analyzed using the Kolmogorov-Smirnov test. Since the data did not meet the normality assumptions, the Mann-Whitney U test was used to compare quantitative variables between the groups. The Chi-square test was used to compare percentages of the categorical variables between the groups. The ANCOVA test was used to assess covariate effect of the duration since HSCT on recorded outcomes. The two-way ANOVA was used to assess interaction between the transplantation type and the presence of anemia on recorded outcomes.

RESULTS

A total of 82 patients (Female/Male: 41/41) treated with HSCT and referred to Faculty of Physical Therapy and Rehabilitation at Hacettepe University were included. The number of patients assigned to the Group 1 and Group 2 were 40 and 42; respectively. Power analysis (Gpower 3.0.10 program) was calculated according to the BI reached 97% power in the 95% confidence interval ($p<0.05$). Since significant difference was found in the BI and 30-sec SST between groups after adjusting data according to the time since HSCT, the power analysis was performed based on the BI scores.

There was no significant difference between the groups in terms of demographic and medical characteristics except for duration since HSCT. The percentage of patients with comorbidity and HSCT-related complications were low in both groups. The demographic and medical data were presented in Table 1.

According to the group comparisons in terms of physical functions, patients with anemia had significantly lower scores in knee extensor muscle strength, the 30-sec SST, and the BI than patients without anemia ($p<0.05$). The comparison analysis between the groups were showed in Table 2. Since the duration after HSCT was significantly lower in patients with anemia, we performed further analysis to assess covariate effect of the duration since HSCT. As a result of the ANCOVA, there was still a significant difference in 30-sec SST [F (1.59) =

Table 2. Comparison of Physical Functions of Patients with and without Anemia

	Group 1 (n=40) Median (Min-Max)	Group 2 (n=42) Median (Min-Max)	z	p
Fatigue, Visual Analogous Scale				
Resting	0.00 (0.00-2.00)	0.00 (0.00-3.00)	-0.663	0.507
Activity	0.00 (0.00-4.00)	0.00 (0.00-5.00)	-1.189	0.235
Handgrip strength, kgf	23.30 (10.00-41.33)	26.80 (15.60-47.30)	-1.584	0.113
Peripheral muscle strength, N				
Shoulder flexor	87.49 (51.30-136.60)	92.30 (45.30-137.66)	-0.878	0.380
Elbow flexor	117.50 (80.00-172.60)	130.13 (83.30-179.00)	-0.138	0.890
Hip flexor	107.49 (55.70-189.66)	119.50 (88.00-146.33)	-0.323	0.747
Knee extensor	129.50 (101.50-293.33)	150.00 (108.66-197.50)	-2.239	**0.025**
The 30-second sit to stand test	13.00 (10.00-23.00)	19.00 (15.00-24.00	-4.925	**0.001**
Barthel Index	100 (65-100)	100 (80-100)	-2.601	**0.009**

Mann-Whitney U test, *p<0.05

28.220, p<0.001] and the BI score [F (1.75) = 6.571, p=0.012] between the groups whilst adjusting for duration since HSCT. A two-way ANOVA was conducted to examine the effect transplantation type and the presence of anemia on recorded outcomes. There was no statistically significant interaction between the effects of transplantation type and the presence of anemia on recorded outcomes (p>0.05).

DISCUSSION

The differences in physical functions of patients with and anemia during the post-HSCT period were investigated. The results revealed that quadriceps femoris muscle strength, functional performance, and ADL level in patients with anemia were lower than patients without anemia. Patients with anemia had still poorer functional performance and ADL level than patients without anemia when time since HSCT was adjusted across the groups. Additionally, there was no interaction between transplantation type and the presence of anemia on the results.

As far as known, there is no study which compared physical functions according to the presence of anemia in patients undergoing HSCT. When considered high proportion of patients treated with HSCT have anemia (4), the effect of anemia on physical functions may have been ignored by physical therapists or rehabilitation specialists. For this reason, it was aimed to compare physical functions according to the presence of anemia in patients treated with HSCT. The impact of anemia on physical functions have been investigated in different cases in the literature (7-12). Duration since HSCT may have an impact on the physical functions as reported by the previous studies. According to a previous study, as duration since HSCT increased, patients' functional level was also improved (13). In our study, duration since HSCT was significantly different between the groups. For this reason, adjusted groups in terms of duration since HSCT were used to understand the impact of anemia.

Low level of fatigue difference across the groups were recorded in the present study. Additionally, the groups had similar fatigue severity. In a relevant previous study performed on community-dwelling elderly persons, a relation between fatigue and anemia was reported (22). This inconsistency may be due to different methodologies used for fatigue assessment. Assessment of fatigue level using VAS in this study might have been insufficient to define any difference between the groups. Similarly, VAS was used to evaluate fatigue level and no association with hemoglobin level has been reported in lung cancer patients receiving chemotherapy (7). We suggest that multidimensional fatigue assessment and its' association with hemoglobin level should be further investigated in patients treated with HSCT.

With regard to muscle strength of the participants, there was no significant difference between the groups except for quadriceps femoris muscle strength. Several studies have shown decreased muscle strength capacity in patients with anemia when compared with the ones without anemia (12,22). Poor muscle oxygenation was suggested as the reason for this weakness (6). In this study, anemia was associated with lower extremity muscle weakness, yet there was no relation with the upper extremity muscle strength. On the contrary, there was significant association between upper extremity muscle strength and anemia in previous studies (23,24). The long-time immobilization and inactivity of patients with HSCT may have more detrimental effect on lower extremity strength than upper extremity which have been reported previously (24). However, there is no data regarding the patients' physical activity level during the HSCT process. On the other hand, immunopathogenetic nature of the diseases may also impact muscle strength which was reported previously (25). Therefore, more studies are needed to highlight effects of anemia on different body functions and variables such as hospitalization, patients' previous physical activity level, and immunopathogenetic nature of the diseases.

In a previous study, it was reported that muscle strength decreased and poor muscle strength persisted after adjusting duration since treatment in patients with both hematologic malignancy and anemia (12). In the present study, since duration was significantly different between groups, data was adjusted to this variable. After data was adjusted, there was no significant difference in muscle strength across the groups. Therefore, it is con-

sidered that muscle weakness was associated with duration since HSCT in the present study. There was only one study that investigated the effect of change in hemoglobin level on muscle strength in patients treated with HSCT, and no interaction was found (13). Therefore, we suggest that muscle strength is influenced by multiple factors and the presence of anemia or duration since HSCT alone does not explain muscle weakness in patients treated with HSCT.

Patients with anemia showed weaker functional performance as measured with the 30-sec SST than patients without anemia in the present study. Similar findings have been reported in different populations with anemia (26, 27). Decrease in functional performance have been attributed to decrease in oxygenation of human body during functional activities (26). In addition, since quadriceps femoris muscle strength was lower in anemia group, this might have led to a decrease in the 30-sec SST performance. Because, one of the primary responsible muscle during sit to stand activity is quadriceps femoris (28). On the other hand, our finding was regardless from the type of transplantation. Further research is needed to highlight functional problems related to anemia in cancer patients (especially hematological cancer) and patients treated with HSCT. It is suggested that when evaluating functional performance capacity of patients treated with HSCT, hemoglobin level should also be considered by physiotherapists.

Regarding ADL, patients with anemia showed lower ADL capacity than patients without anemia. Similarly, lower ADL level have been found in previous studies and this result have been attributed to a high fatigue level in patients with anemia (7,29,30). Patients' fatigue level was low in the present study, yet this was our limitation that we assessed fatigue only with VAS. Therefore, assessment of fatigue using one question may be insufficient to determine fatigue severity in the patients. On the other hand, anemia was associated with poor functional capacity which may lead to decrease in independency in ADL. This result suggests that ADL should be examined in more detail in patients with anemia during clinical practice by physiotherapist and/or rehabilitation specialists. Since Barthel Index which was used in this study asks only about basic daily living activities, further studies should also examine the instrumental daily living activities. In accordance with the findings, it is advisable to physiotherapists to prescribe programs including muscle strengthening exercises, functional activities, and ADL training for patients with anemia.

Limitations of the Study The present study has some limitations. Firstly, the patients with no physical assessments were excluded. Therefore, patients with higher motivation may have been included in the present study. Additionally, since this study has a retrospective design, some data could not be collected such as hospitalization time during HSCT, medication use, and immunopathogenetic nature of the diseases. Lastly, VAS may not be a sufficient questionnaire to determine fatigue level in patients treated with HSCT. Therefore, use of a multidimensional fatigue assessment to evaluate fatigue level in patients with anemia is suggested.

Conclusion

In conclusion, patients with HSCT-related anemia have weaker quadriceps femoris muscle strength, decreased physical performance, and more dependency in ADL than the patients without anemia. Duration since HSCT have been also considered as a confounder for muscle strength. It is suggested that deficiency in muscle strength of HSCT patients is multifactorial and should be further analyzed. Additionally, poor physical performance and ADL level in patients with anemia are regardless from duration since HSCT. Since anemia has an impact on physical functions of the patients, physiotherapists should be aware regarding the hematological signs.

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ACTN3 R577X POLYMORPHISM AND ANAEROBIC PERFORMANCE IN ULTIMATE FRISBEE PLAYERS: A PRELIMINARY STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: ACTN3 R577X polymorphism is a frequently studied gene polymorphism associated with athletic performance. Studies have demonstrated a strong association between the 577RR genotype and sprint and power-based sports. Ultimate Frisbee (UF) is a physically demanding sport requiring aerobic and anaerobic skills. This study aimed to evaluate the relationship between the ACTN3 R577X polymorphism and the anaerobic power capabilities of UF players.

Methods: The study included 30 UF players in the study group (mean age ± SD 21.03 ± 2.04 years) and 30 volunteers in the control group (mean age ± SD 22.17 ± 1.39 years). Anaerobic power was assessed using vertical jump, running-based anaerobic sprint (RAST), triple hop, and closed kinetic chain upper extremity tests. Blood samples were genotyped using real-time polymerase chain reaction. RR, RX, and XX represent homozygous dominant, heterozygous dominant, and recessive genotypes, respectively.

Results: Fatigue Index (FI) data from RAST test results was the only variable that differed between study and control groups (Study Group: 6.02 ± 3.52 vs. Control Group: 4.17 ± 1.71 watts/sec, p = 0.012). There was no statistically significant difference between the study and control groups in vertical jump, triple hop, and closed kinetic chain upper extremity test results. No statistically significant difference was found in anaerobic performance tests among the genotype groups in UF players.

Conclusion: In this study conducted with limited sample size, the anaerobic performance of UF players was not found to be associated with ACTN3 R577X polymorphism. However, performing the same screening in larger sample groups in future studies may yield more efficient results.

Keywords: ACTN3, Athletic Performance, Genomics, Ultimate Frisbee

ULTIMATE FRISBEE OYUNCULARINDA ACTN3 R577X POLİMORFİZMİ VE ANAEROBİK PERFORMANS: BİR ÖN ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: ACTN3 R577X polimorfizmi, atletik performansla ilişkili olarak sıklıkla çalışılan bir gen polimorfizmidir. Çok sayıda çalışma, 577RR genotipi ile sprint ve güce dayalı sporlar arasında güçlü bir ilişki olduğunu göstermiştir. Ultimate Frisbee (UF) hem aerobik hem de anaerobik beceriler gerektiren fiziksel olarak zorlayıcı bir sporudur. Bu çalışmanın amacı, ACTN3 R577X polimorfizmi ile UF oyuncularının anaerobik güç yetenekleri arasındaki ilişkiyi değerlendirmektir.

Yöntem: Çalışmaya çalışma grubunda 30 UF oyuncusu (ortalama yaş ± SD 21,03 ± 2,04 yıl) ve kontrol grubunda 30 gönüllü (ortalama yaş ± SD 22,17 ± 1,39 yıl) dahil edildi. Anaerobik güç dikey sıçrama, koşuya dayalı anaerobik sprint (RAST), üçlü sıçrama ve kapalı kinetik zincir üst ekstremite testleri kullanılarak değerlendirilmiştir. Kan örnekleri gerçek zamanlı polimeraz zincir reaksiyonu kullanılarak genotiplendirilmiştir. RR, RX ve XX sırasıyla homozigot dominant, heterozigot dominant ve resesif genotipleri temsil etmektedir.

Sonuçlar: RAST testi sonuçlarından elde edilen Yorgunluk İndeksi (FI) verileri çalışma ve kontrol grupları arasında farklılık gösteren tek değişkendi (Çalışma Grubu: 6,02 ± 3,52 vs Kontrol Grubu: 4,17 ± 1,71 watt/sn, p = 0,012). Dikey sıçrama, üçlü sıçrama ve kapalı kinetik zincir üst ekstremite test sonuçlarında çalışma ve kontrol grupları arasında istatistiksel olarak anlamlı bir fark bulunmamıştır. UF oyuncularının genotip grupları arasında anaerobik performans testlerinde istatistiksel olarak anlamlı bir fark bulunmamıştır.

Tartışma: Kısıtlı örneklem sayısı ile yapılan bu çalışmada, UF oyuncularının anaerobik performansı ACTN3 R577X polimorfizmi ile ilişkili bulunmamıştır. Ancak gelecek çalışmalarda aynı taramanın daha büyük örneklem gruplarında yapılması daha verimli sonuçlar verebilir.

Anahtar kelimeler: ACTN3, Atletik Performans, Genomik, Ultimate Frizbi

INTRODUCTION

Athletic performance is affected by genetic predisposition along with external factors like exercise and diet (1). Genetic contributions may explain about 66% of an athlete's condition variability (2). Furthermore, performance in sports is affected by a broad range of phenotypic traits resulting from a combination of many biological, physiological, and biochemical mechanisms (3, 4). Mutations, single nucleotide polymorphisms, DNA polymorphisms, and rare mutations are genetic indicators correlated with athletic traits such as muscular strength, endurance, and power (5). A growing body of evidence suggests significant genetic influences on sports performance, strength, endurance, and speed (5, 6).

Specific genes and gene sequence variants have been linked to athletic performance, but most studies have not been sufficiently repeated. Two exceptions are the α-actinin-3 (ACTN3) R577X polymorphism and the angiotensin-1 converting enzyme insertion/deletion (ACE I/D) polymorphism, which was tested with a variety of experimental approaches in several populations (7-9). It is recognized that ACTN3 R577X and ACE I/D polymorphism variations may play an essential role in achieving superior athletic performance (8, 10, 11). Based on studies on genetics and athletic performance, the ACE gene is closely associated with the endurance phenotype, and the ACTN3 gene with the strength phenotype (1, 5, 9, 10).

ACTN3 is involved in encoding the protein of α-actinin-3, which is produced specifically for type-II myofibrils, which itself has an essential function in producing fast twitches and powerful contractions (5, 10, 12-15). A nonsense polymorphism has been stated in the ACTN3 (rs1815739), the outcome of a substitution of a protein of arginine (R) residue with a premature stop-codon (X), which results in no α-actinin-3 protein detectable in muscle fibers (14). Nearly 18 percent of Caucasians have homozygous stop codon, so there is a complete deficiency in α-actinin-3 (5, 13). Several studies have found that the ACTN3 RR genotype is more overrepresented in sprint or power-oriented athletes than in controls. On the contrary, the XX genotype of the ACTN3 was also found to be overrepresented in endurance-based athletes (1, 9, 10).

Ultimate Frisbee (UF) is a high-paced team sport that involves limited physical contact and is played using a flying disc. It combines elements of soccer, basketball, rugby, and American football. UF is known for requiring a significant amount of high-intensity running, which can lead to fatigue during and after a game (16). Two teams with seven players compete in a 110-by-37-meter area with 23-meter-deep end zones on each side (17). The objective is to score by reaching the opposing end zone with the disc (18). In UF, the field size is akin to a soccer field but different from soccer, with seven players on each team instead of eleven, leading to significant physical demands. Studies have indicated that the expansive field and limited players can elevate the game's intensity (16, 17). Other studies have reported that in comparable sports, such as soccer, the workload increases due to high-paced running during the last 15 minutes of a match, and this temporary fatigue may negatively affect sprint performance (16, 19).

Studies conducted contributed to our understanding of the basic mechanisms of the UF; it consists of frequent running, change of direction, rapid acceleration, deceleration, jumping, and sprinting (16, 19). Moreover, according to a study, the UF could be described as a very energetically demanding sport with both aerobic and anaerobic characteristics. During an average match, it has been reported that players perform high and low-intensity running and sprints of relatively short duration and cover distances ranging from 4000 meters to 5000 meters (16, 20). In addition, it was reported that players spent approximately 42% of match time above >90% HRmax. Fatigue also plays a significant role in performance, with high-intensity running required throughout and specifically in the final parts of the game. It was reported that running distances were also compared between halves during the UF match, and a decrease in high-intensity running distance was found at the end of both halves. The authors thought the decline in the running distance was associated with increased fatigue and decreased anaerobic capacity and emphasized the importance of anaerobic performance

for UF sport (16). According to another study's results, blood lactate levels' findings also support the importance of the anaerobic performance capacity of UF athletes (19).

As far as the current knowledge goes, there is a limited number of physiological studies in the literature investigating the blood lactate levels and heart rate (HR) levels of UF athletes during the game. However, as far as we know, no research has examined the link between genetic factors and athletic performance in this sport (16, 18, 19). This study aimed to assess the relationship between the ACTN3 R577X polymorphism and the anaerobic power performance of UF athletes. It was hypothesized that there was a statistically significant difference between anaerobic performance findings and genotype groups of ACTN3 R577X polymorphism among UF players.

METHODS

Design

For this cross-sectional study, physical performance tests were performed in the synthetic turf field and the university's physiotherapy and rehabilitation department laboratory. A physiotherapist carried out all performance assessments. The subjects were asked to control their intake of caffeine and alcohol two days before the test and to avoid vigorous exercise for at least the previous 48 hours. The evaluations were divided into two parts: performance tests were performed in the first part, and blood samples were taken in the second part. Each episode was held on separate days during the same week. After the performance measurement process of all participants was completed, the blood sample collection phase started. After conducting individual interviews with the participants, appropriate appointment days were scheduled, and a single blood sample was collected from each participant using one tube. The research sample was collected between January 2020 and May 2020.

Participants

The study group (SG) consisted of thirty healthy UF players who were not diagnosed with any cardiovascular disease, did not have any musculoskeletal injury, and have been playing UF for at least six months. The control group (CG) consisted of thirty healthy individuals who were not diagnosed with any cardiovascular disease, had no musculoskeletal injury, and were not a member of any competitive sports team. The primary sociodemographic data of the participants and the factors related to their health status were collected using a structured face-to-face questionnaire. This questionnaire included questions about the participants' age, height, weight, body mass index (BMI) health habits, health status, injuries, current diseases, and length of participation in the team. Voluntary participants in the two groups were determined to participate in the study using the following inclusion and exclusion criteria:

Inclusion criteria:

- Have not undergone any surgical intervention in the lower or upper extremities in the last six months
- Have not experienced any orthopedic injuries in the last six months
- Being in the age range of 18-25
- Volunteer to participate in the study

Exclusion criteria:

- Having any diagnosed cardiorespiratory disorders
- Any musculoskeletal trauma in the last six months
- Participants with other diseases that may cause clinical symptoms, such as systemic diseases,
- Not to be in the 18-25 age range
- Not volunteering to participate in the study

Ethics statement

This study adhered to the principles of the Declaration of Helsinki. Written informed consent was acquired from every participant, and the research received approval from the Ethics Committee at Yeditepe University Faculty of Medicine (Decision No: 37068608-6100-15 / 1095).

Sampling

To determine the sample size for this study, we based our calculations on the estimated effect size (d=1.64) derived from the vertical jump test values

reported in a previous study in the literature (21). Although there are no established cutoff values in the literature for the vertical jump test, the normative values for vertical jump height in the young adult age group were reported as 56.38 ± 8.89 cm in the study conducted by Patterson et al. (22). Using the estimated effect size obtained from the study's data, the alpha level (α) was 0.05, and the power was 0.95. Thus, it was accepted as the sample size of 22 participants, with a minimum of 11 subjects in each group.

Anaerobic performance testing

Four tests were used to evaluate anaerobic performance: the Vertical Jump Test, the Running-based Anaerobic Sprint Test (RAST), the Triple Hop for Distance Test, and the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST). All participants performed a standard warm-up exercise before their performance tests.

For the vertical jump test, the fingertip of the third finger of the athlete was labeled with chalk. The athlete stood near the wall, maintaining both feet on the floor, extending as high as possible with one side, and labeling the wall with the endpoint of the third finger. This first point of touch was called the point of M1. The athlete tried to jump as high as possible and left a mark by touching the point where they reached the highest point with her fingertip. This point was referred to as the M2 point. The observer calculated the distance from M2 to M1. The athletes performed the test three times. The observer calculated the distances and average distances obtained in all three jumps. This value was used to measure the power. Harman Formula was used to calculate the peak and average power. The ICC value of the vertical jump test was reported as 0.98 based on measurements in healthy athletes (23).

The RAST protocol consists of six sprints with maximal effort on a 35-meter line with 10-second intervals for recovery. The times of the six sprints were recorded separately. The anaerobic power (calculated as watts) performance of each run was estimated from the following equivalence: Power = (force x speed) or (body mass x distance2) / time3) (24). The Fatigue Index (FI) value was calculated when the minimum power was subtracted from the maximum power and divided by the duration of a total of 6 sprints. Anaerobic Capacity (AC) was calculated when the power outputs of 6 sprints were added. The RAST test helps assess anaerobic power output (ICC = 0.88) (25).

The parallel tape was placed on the floor about 15 cm wide for the triple hop for the distance test. The athlete was asked to stand on the extremity to be tested just behind the starting line. Throughout the straight line, the athlete was asked to jump three times consecutively with maximum effort on the dominant leg. The test was conducted three times, and the recorded result was the mean of the total distance. The Triple hop for distance test has been reported to be a reliable alternative for assessing the power elicited by the lower extremity (ICC = 0.92) (26).

To perform the CKCUEST, a non-slip surface, two pieces of athletic tape, and a chronometer were used. Lines were formed with two athletic bands spaced 0.9 m apart. The athlete was asked to take a standard push-up position with their hands next to the lines. Then, the athlete was asked to move their hands from one line to the other line as quickly as possible. The number of touches to lines in 15 seconds was recorded. The average sum of the number of touches obtained in three trials was calculated. The score and the power can be determined by the following formulas: Score = the average number of touches / Height (inch); Power = (68% of body weight x the average number of touches) / 15. The ICC value of the CKCUEST test was reported as 0.927 (27).

Blood sample collection and genetic analysis

All venous blood samples from the participants were collected in 5 ml tubes containing Ethylenediaminetetraacetic acid (EDTA), ensuring their safety. These peripheral venous blood samples were stored at -80 °C, maintaining their integrity. The tubes were equipped with EDTA to prevent blood clotting. DNA isolation was performed using the iPrep pure link system from Invitrogen, a division of Thermo Fisher Scientific Inc. DNA extraction was automated using the iPrep DNA extraction robot (Invitrogen, Carlsbad, California, USA) and the blood genomic DNA isolation kit with iPrep. The purity and concentration of DNA were assessed using

NanoDrop (Invitrogen, Carlsbad, California, USA).

The allele and genotype frequencies were assessed for Hardy-Weinberg equilibrium using chi-squared tests. Genotyping analysis was performed using the 7500 Fast Real-Time Polymerase Chain Reaction (Applied Biosystems, Foster City, CA) system. Molecular beacons were employed in the Real-Time PCR to identify the SNPs. These molecules give fluorescent light when hybridization with a supplementary target region. As supplementary target areas are present, molecular beacons open due to the connecting DNA sequences to supplement target regions. Fluorescent signals can be easily detected. Molecular beacons used in Real-Time PCR have two different wavelengths for allele-specific detection: wildtype and mutant alleles (28). The R577X polymorphism of ACTN3 was specified using PCR. We conducted genotyping to isolate a specific segment of the gene and analyze the ACTN3 R577X polymorphism. The targeted genetic region for genotyping was rs1815739 within the ACTN3 gene. The conditions for the Real-Time PCR were set with an initial 10-minute incubation at 95°C, followed by denaturation at 92°C for 15 seconds in each cycle and annealing/elongation at 60°C for 1 minute in each cycle. The denaturation and annealing/elongation steps were repeated for 40 cycles.

Statistical analysis

The data underwent analysis through SPSS for Windows (Version 25.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation (SD). The normality of variables was assessed using the Shapiro-Wilk test. The Mann-Whitney U test was chosen for non-normally distributed data, while the independent t-test was applied to normally distributed data. Comparison of performance values between genotype groups in the study and control groups was evaluated using one-way or multivariate analysis of variance (ANOVA) with the post hoc Tukey test. The threshold for statistical significance was established at $p<0.05$. Allelic and genotype frequencies were analyzed using Fisher's exact or chi-squared (x2) test. The x2 test was employed to assess the conformity of genotypic frequencies with Hardy-Weinberg expectations (29).

RESULTS

Physical features of participants

This study involved 30 athletes (21 males, 9 females; 21.03 ± 2.04 years) from Yeditepe University UF Team and 30 healthy individuals (19 males, 11 females; 22.17 ± 1.39 years) from Yeditepe University students. While there was no significant difference in height, weight, and BMI between the SG and CG, a statistically significant difference in age ($p < 0.05$) was evident between the two groups (Table 1).

Table 1. Physical Features of Participants (mean ± SD)

	SG (n = 30) (mean ± SD)	CG (n = 30) (mean ± SD)
Age (years)	21.03 ± 2.04*	22.17 ± 1.39
Height (cm)	175.87 ± 9.08	174.80 ± 8.74
Weight (kg)	69.97 ± 11.13	69.60 ± 12.93
BMI (kg/m^2)	22.54 ± 2.73	22.56 ± 2.27

Note: Independent samples t-test was used to compare variables showing normal distribution data between independent groups. *p < 0.05, compared with CG.

BMI: body mass index, SG: study group, CG: control group.

Genotype distributions ACTN3 R577X among groups

According to the distribution of genotype characteristics among the SG and the CG, the RR (n=12), RX (n=13), and XX (n=5) were determined. In addition, RR (n=12), RX (n=11), and XX (n=7) were determined in the control group (Table 2). Based on the chi-squared test outcomes, genotype frequencies in both groups were found to conform to Hardy-Weinberg equilibrium ($p > 0.05$).

Table 2. Genotype Distribution of Genotypes

	SG (n=30)	CG (n=30)
XX	17%	23%
RX	43%	37%
RR	40%	40%
HWE-*p value*	0.647	0.178

Note: The genotype frequencies determined according to Hardy-Weinberg equilibrium by chi-squared tests.

SG: study group, CG: control group, RR: homozygous dominant, RX: heterozygous dominant, XX: homozygous recessive, HWE: hardy-weinberg equilibrium.

Intergroup comparison of the anaerobic performance test results

The Independent Samples t-test was used to compare the anaerobic performance variables between the SG and CG. No statistically significant differences were found between the groups in vertical jump tests, closed kinetic chain upper extremity tests, and triple hop test results ($p > 0.05$). The FI was the only variable that showed a statistically significant difference between the groups ($p < 0.05$) (Table 3).

Table 3. Intergroup Comparison of the Anaerobic Performance Test Results

	SG (n = 30) (mean ± SD)	CG (n = 30) (mean ± SD)
VTJ distance (cm)	45.89 ± 11.58	41.64 ± 9.66
PAP (watts)	7187.82 ± 970.04	6905.21 ± 945.67
AAP (watts)	1189.24 ± 429.07	1090.63 ± 447.62
PPO (watts)	506.53 ± 171.04	460.58 ± 154.96
APO (watts)	385.34 ± 120.31	384.65 ± 131.58
MPO (watts)	285.52 ± 105.47	309.93 ± 111.46
RPPO (watts)	7.14 ± 1.91	6.58 ± 1.54
FI (watts/sec)	6.02 ± 3.52*	4.17 ± 1.71
AC (watts)	2312.05 ± 721.91	2307.94 ± 789.50
CKCUEST Touch (number of touches)	27.90 ± 4.44	26.63 ± 4.27
CKCUEST Score (touches/inch)	0.40 ± 0.06	0.39 ± 0.05
CKCUEST Power (watts)	89.01 ± 21.40	85.11 ± 24.89
Triple Hop Distance (cm)	536.15 ± 90.40	530.34 ± 87.51

Note: Independent samples t-test was used to compare variables showing normal distribution data between independent groups. *$p < 0.05$, compared with CG.

SG: study group, CG: control group, VTJ: vertical jump test, PAP: peak anaerobic power output for the VTJ, AAP: average anaerobic power output for the VTJ, PPO: peak power output for the running-based anaerobic sprint test (RAST), APO: average power output for the RAST, MPO: minimum power output for the RAST, RPPO: relative peak power output for the RAST, FI: fatigue index for the RAST, AC: anaerobic capacity for the RAST, CKCUEST: closed kinetic chain upper extremity stability test.

Intragroup comparison of the anaerobic performance test results for the study group

The One-way ANOVA test was employed to compare anaerobic performance variables among the study group's RR, RX, and XX genotype groups. The statistical analysis revealed no significant difference between vertical jump test parameters groups. Similarly, the findings indicated no significant difference according to genotype groups regarding RAST parameters. Moreover, the statistical analysis showed no significant difference in CKCUEST parameters in the genotype groups. Finally, there was no significant difference between the genotype groups in triple hop distances (Table 4).

Table 4. Intragroup Comparison of the Anaerobic Performance Test Results for the Study Group (UF Players)

	RR (n = 12) (mean ± SD)	RX (n = 13) (mean ± SD)	XX (n = 5) (mean ± SD)
VTJ distance (cm)	45.19 ± 11.49	45.53 ± 13.71	48.53 ± 5.90
PAP (watts)	7172.36 ± 1083.86	7141.25 ± 1009.55	7310.01 ± 712.59
AAP (watts)	1196.14 ± 498.16	1169.96 ± 416.79	1222.83 ± 358.28
PPO (watts)	508.24 ± 179.05	494.32 ± 150.93	534.13 ± 232.70
APO (watts)	371.56 ± 131.48	390.99 ± 108.81	403.70 ± 144.21
MPO (watts)	271.20 ± 121.43	292.40 ± 96.09	307.99 ± 104.95
RPPO (watts)	7.04 ± 1.90	7.10 ± 1.82	7.49 ± 2.51
FI (watts/sec)	6.32 ± 3.09	5.59 ± 3.76	6.41 ± 4.49
AC (watts)	2229.41 ± 788.88	2345.95 ± 652.90	2422.24 ± 865.29
CKCUEST Touch (number of touches)	27.17 ± 5.76	28.62 ± 3.01	27.80 ± 4.60
CKCUEST Score (touches/inch)	0.39 ± 0.08	0.41 ± 0.04	0.40 ± 0.06
CKCUEST Power (watts)	88.17 ± 25.41	90.25 ± 17.46	87.81 ± 24.92
Triple Hop Distance (cm)	540.00 ± 104.68	539.38 ± 87.11	518.50 ± 76.71

Note: The One-Way ANOVA test was used to compare anaerobic performance variables in the study group regarding the genotype variants.

SG: study group, CG: control group, VTJ: vertical jump test, PAP: peak anaerobic power output for the VTJ, AAP: average anaerobic power output for the VTJ, PPO: peak power output for the running-based anaerobic sprint test (RAST), APO: average power output for the RAST, MPO: minimum power output for the RAST, RPPO: relative peak power output for the RAST, FI: fatigue index for the RAST, AC: anaerobic capacity for the RAST, CKCUEST: closed kinetic chain upper extremity stability test, RR: homozygous dominant, RX: heterozygous dominant, XX: homozygous recessive

DISCUSSION

This study examined the relationship between anaerobic power variables and the ACTN3 R577X polymorphism among UF players. The genotype

frequencies for RR, RX, and XX among UF players were 40%, 43%, and 17%, respectively. Moreover, the observed genotype frequencies of ACTN3 gene R577X polymorphism in all three groups were found to be consistent with Hardy-Weinberg equilibrium ($x2 = 0.208$, $p = 0.647$; $p > 0.05$ - consistent with HWE). One of the other findings was that there was no significant difference in anaerobic performance variables among the different genotype groups of the ACTN3 R577X polymorphism. Eynon et al. conducted a study involving athletes from three European countries, categorizing them into team sport athletes, endurance athletes, and sprint/power athletes (30). They compared the genotype and allele frequencies among these groups and found that team athletes were less likely to possess the 577RR allele than sprint/power athletes. This discrepancy is attributed to the differing physical demands of team sports, which are intermittent and require repeated powerful movements such as short-distance sprints and jumps. Massidda et al.'s study on Italian athletes corroborated Eynon et al.'s findings (30, 31). Therefore, the literature revealed that the ACTN3 R577X polymorphism was not associated with team sports performance (30). According to the results of our study, we similarly concluded that there was no association in UF athletes.

The ACTN3 R577X polymorphism has shown a significant correlation with athletic performance in various sports disciplines, including team sports like football, handball, and ice hockey; sprint/power sports such as sprinting and weightlifting; and endurance sports such as rowing, endurance road cycling, and marathon running (5, 30, 32, 33). No studies have examined genetic polymorphism in UF players, making it challenging to compare genotype distributions. Previous studies have explored various physiological parameters in UF (16, 18, 19). A study demonstrated that UF players cover approximately 4000 to 5000 meters in a typical 50-minute match. Additionally, it was reported that players spent around 42% of the match time above 90% of their maximum heart rate (HRmax). Based on this information, the study concluded that UF is a high-intensity intermittent sport characterized by extensive running, sprinting, and a substantial cardiovascular load (16). Another study evaluating HR, perceived exertion, and blood lactate levels in UF players during a match found that HR values were vigorous (mean±SD = 94.3±5.1 %HRmax) according to ACSM guidelines (19). Borg's scale indicated RPE values of 13.85±2.11, classifying them as moderate to high exertion levels. These results suggest that UF athletes likely performed consistently above their anaerobic threshold, increasing reliance on the anaerobic glycolytic energy system to sustain exercise intensity. This hypothesis is further supported by the athletes' average blood lactate levels of 4.7 to 8.3 mmol·L-1 during the match, exceeding the general anaerobic threshold indicator of 4 mmol·L-1. Considering the lactate levels, the importance of anaerobic capacity in UF sports is recommended in the literature. We employed valid and reliable tests to ensure the practical assessment of anaerobic performance (23, 25-27).

Numerous studies have associated the 577RR genotype with sprint and power-type disciplines (30, 32-34). Conversely, the XX genotype is more prevalent among endurance athletes (10, 35). However, these findings remain a subject of ongoing debate and further investigation. Importantly, although our study could not demonstrate a relationship with anaerobic performance, we found that the genotype distributions were consistent with the team sport studies conducted by Eynon and Massidda et al. In both our research and the studies conducted by Eynon and Massidda et al., the most prevalent genotype among team athletes was RX (40-54%), followed by RR (33-43%) and XX (13-20%) (30, 31). These findings underscore the significance of incorporating anaerobic training into the training regimens of UF team players. Kobayashi et al. studied the ACTN3 R577X polymorphism, examining Japanese athletes' bone mineral density (BMD) and maximal anaerobic power output (36). They concluded that athletes with the RR genotype exhibited higher BMD and maximal anaerobic power output than other genotypes. This suggests that individuals with the RR genotype may have more favorable training responses. These findings could inform the regulation of training programs and determine optimal training strategies through genotyping, potentially enhancing sports performance. Although not the current study's primary aim, various parameters related to anaerobic performance, such as muscle architecture, bone mineral density,

and metabolic pathway efficiency, may also be considered. Other possible genetic factors and polymorphisms influencing athletic performance should also be considered. Consequently, taking these factors into consideration, a multifactorial study design could be adopted for similar future research (37, 38).

This study has several limitations that should be acknowledged. First, the small sample size limits the generalizability of the findings. Second, this study did not evaluate other physiological factors influencing performance. Third, the study did not assess the effects of other potential variables on anaerobic performance; these variables may impact an athlete's anaerobic capacity. Given these limitations, future research should adopt a multifactorial approach, incorporating a broader range of variables to provide a more comprehensive understanding of the factors influencing anaerobic performance in UF players.

In conclusion, the authors believed that this study provided relevant findings that underscored the significance of incorporating anaerobic training into the training regimens of UF team players.

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Author Contributions: Concept - MAP, OK, SGY, FS, Tİ; Design - MAP, FS, Tİ; Supervision - FS, Tİ; Resource Support -OK, SGY, Tİ; Materials - MAP, SGY, FS, Tİ; Data Collection and/or Processing - OK, MAP, SGY, Tİ; Analysis and/or Interpretation - SGY, MAP, FS; Literature Review - MAP, FS; Writing Manuscript - MAP, SGY, FS; Critical Review - OK, SGY, FS, Tİ

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CİNSİYETE GÖRE FEMUR UZUNLUĞUNUN QUADRICEPS VE HAMSTRING İZOKİNETİK KUVVET ÖZELLİKLERİNE ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışma, günlük hayatta aktif olan fakat düzenli spor yapmayan bireylerde femur uzunluğu ile quadriceps ve hamstring kuvveti ve dayanıklılığı arasındaki ilişkiyi belirlemek amacıyla yapıldı.

Yöntem: Çalışmaya 43 kadın (ortalama yaş: 34,60 yıl) ve 47 erkek (ortalama yaş: 34,95 yıl) gönüllü birey katıldı. Katılımcıların femur uzunluğu ve izokinetik kas kuvvet özellikleri ölçüldü. Ayrıca, fiziksel aktivite düzeyleri Uluslararası Fiziksel Aktivite anketinin kısa formu (IPAQ) ile değerlendirildi.

Sonuçlar: Q ve H pik tork, pik tork/vücut ağırlığı, total iş, total iş/vücut ağırlığı, Hamstring/Quadriceps oranı erkeklerde daha yüksek bulundu ($p<0,01$). Spearman's rho korelasyon analizine göre, kadınlarda femur uzunluğu ile diz ekstansör kas kuvveti, kas dayanıklılığı, pik tork/vücut ağırlığı, total iş/vücut ağırlığı arasında pozitif korelasyon bulundu ($p<0,05$). Erkeklerde ise sadece 60°/sn hızda femur uzunluğu ile total iş arasında pozitif korelasyon tespit edildi ($p<0,05$).

Tartışma: Sonuç olarak, kas kuvveti, kas dayanıklılığı, kilogram başına düşen kas kuvveti açısından erkeklerin kadınlara göre daha avantajlı olduğu görüldü. Ek olarak H/Q oranının artması ile erkeklerde diz eklem stabilitesinin arttığı ve yaralanma riskinin azaldığı sonucuna varıldı. Femur boyu uzun olan kadınların kas kuvveti açısından kısa olanlara göre daha avantajlı ve özellikle diz ekstansör kaslarının daha kuvvetli ve daha dayanıklı olduğu gözlendi. Erkeklerde ise femur boyunun uzun olması kas kuvvetinden ziyade kas dayanıklılığı ile ilişkilendirildi. Sonuç olarak femur boyunun uzun olmasının kişiye kas kuvveti ve dayanıklılığı açısından avantaj sağladığı sonucuna varıldı.

Anahtar kelimeler: Antropometri, Femur Uzunluğu, İzokinetik Kas Kuvveti

EFFECT OF FEMUR LENGTH ON QUADRICEPS AND HAMSTRING ISOKINETIC STRENGTH PROPERTIES ACCORDING TO GENDER

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study was carried out to determine the relationship between femur length, quadriceps and hamstring strength and endurance in individuals who are active in daily life but do not do regular sports.

Methods: 43 women (mean age: 34.60 years) and 47 men (mean age: 34.95 years) volunteers participated in the study. The femoral length and isokinetic muscle strength characteristics of the participants were measured. In addition, physical activity levels were evaluated with short form of the International Physical Activity Form (IPAQ).

Results : Q and H peak torque, peak torque/body weight, total work, total work/body weight, Hamstring/Quadriceps ratio were found to be higher in males ($p<0.01$). According to Spearman correlation analysis, a positive correlation was found between femur length and knee extensor muscle strength, muscle endurance, peak torque/body weight, total work/body weight in women ($p<0.05$). On the other hand, a positive correlation was found between femur length and total work at only 60°/sec speed in men ($p<0.05$).

Conclusion: As a result, it was seen that men were more advantageous than women in terms of muscle strength, muscular endurance and muscle strength per kilogram. In addition, it was concluded that with the increase of the H/Q ratio, knee joint stability increased and the risk of injury decreased in men. It was observed that women with longer femur lengths were more advantageous in terms of muscle strength than short ones, and especially their knee extensor muscles were stronger and more durable. In men, longer femur length was associated with muscular endurance rather than muscle strength. As a result, it was concluded that having a long femur length provides an advantage in terms of muscle strength and endurance.

Keywords: Anthropometry, Femur Length, Isokinetic Muscle Strength

GİRİŞ

Kas torku, 'F' kuvveti ile 'r' kaldıraç kolunun uzunluğunun çarpılmasıyla elde edilir. Kaldıraç kolu ise F kuvvetinin yönüne dik, eklemin dönüş eksenine olan mesafesidir. Bu nedenle kasların oluşturduğu torkun yani kuvvetin ekstremite uzunluklarıyla ilişkili olması beklenir (1).

Kas kuvveti, bir kasın maksimum eforla üretebileceği kuvvet veya torku ortaya çıkarma yeteneğidir. Yaş, cinsiyet, kasın enine kesit alanı, kas lifi tipi, kontraksiyon tipi, fiziksel şartlar, Beden Kitle İndeksi (BKİ), fiziksel aktivite düzeyi, beslenme faktörleri kas kuvvetini etkiler. İzokinetik, izotonik veya izokinetik olarak değerlendirilebilir (2-4). Kas kütlesinin ve hızlı kasılan kas liflerinin fazla olmasından dolayı erkeklerde kas kuvveti yüksektir (3,4).

Kas kuvveti, birim zamanda kasın en yüksek efor ile dirence karşı sarf ettiği güç veya kişinin belirli zaman içinde kasta oluşan kuvvet veya torku ortaya koyabilme yeteneği olarak tanımlanabilir ve yaş, cinsiyet, kasın enine kesit alanı, kas lifinin tipi, kontraksiyon tipi, fiziki şartlar, yorgunluk, fiziksel aktivite, beslenme gibi faktörler de kas kuvveti üzerinde etkilidir (2-4). Kas kütlesinin ve hızlı kasılan kas liflerinin fazla olmasından dolayı erkeklerde kas kuvveti yüksektir (3,4).

Büyüme ve gelişmeyle artan kas kuvvetine paralel kemik kütlesi ve geometrisinde de değişimler meydana gelir. Wolff Yasası olarak ifade edilen bu etkileşimde kaslar büyüdükçe ve geliştikçe kemik kütlesi de mekanik bütünlüğü korumak için değişir ve yeniden şekillenir. Bu durum çeşitli sporla uğraşan kişilerdeki kemik geometrisi-kas kuvveti farklılığını açıklar (5). Hentbol oyuncularının uzun el, kol ve bacaklara sahip, geniş omuzlu, daha düşük brakiyal indeksli olması (6), haltercilerin kısa boy ve kısa uzuv segmentine sahip olmaları (7), yüzücülerin geniş omuzlu, geniş kol açılığı ve uzun ekstremitelere ve gövdeye sahip olması (8,24) örnek olarak gösterilebilir.

Powerlift sporunu yapan erkek sporcularda kemik geometrisi-kas kuvvet ilişkisini değerlendiren Ferland ve diğ. (2020) ise yapılan spora bağlı gelişen adaptasyona bağlı olarak femur uzunluğunun kas kuvvetine etki ettiğini tespit etmişlerdir. Çalışma sadece erkeklerde yapıldığından kadınlar ile kıyaslama yapılmamıştır (9).

Çalışmalar sporcularda segment uzunluğu ile kas kuvveti ilişkisinin var olduğunu gösterdiğinden düzenli spor yapmayan fakat günlük yaşantısında fiziksel olarak aktif kişilerde de bu durumun olabileceğini akla getirmektedir. Kranick (2016), 150 dakika orta yoğunlukta fiziksel aktivite yapan ve yapmayan toplam 13 kişiden oluşan bu iki grupta yaptığı çalışmada örneklem grubunun yetersizliğinden femur boyu ile kas kuvveti arasında herhangi bir ilişki bulamamıştır (10). Daly ve diğ. (2008) ise 103 prepubertal kız grubunda yaptığı çalışmada femur boyunun kas kuvveti ile pozitif korelasyon gösterdiğini bulmuştur (11). Yani örneklem sayısı, yaş grubu, cinsiyet gibi parametreler uzunluk ve kuvvet ilişkisinde önemlidir.

Değerlendirilen kas kuvvetinin yanında, bu kuvvetlerin birbirine oranı yani H/Q oranı da önemlidir. H/Q oranı, diz eklem stabilizasyonu ve diz eklemi yaralanması yatkınlığının bir göstergesidir. Bu değerin yüksek olması temas olmadan meydana gelen yaralanmalar da dahil alt ekstremite yaralanmalarını önler.

Yapılan çalışmalarda genellikle sporcular üzerine yoğunlaşılmıştır. Düzenli spor yapmayıp fiziksel olarak aktif bireylerde yapılan çalışmalarda ya örneklem sayısı yetersiz ya da yaş aralığı küçüktür. Buradan hareketle günlük yaşamında spor yapmayan fakat fiziksel açıdan aktif yetişkin bireylerde femur boyunun kişiye avantaj mı yoksa dezavantaj mı sağlayacağını, bireyin yapacağı herhangi bir kuvvetlendirmede femur boyunun kas kuvvetine pozitif yönde etki edip etmediğini belirlemek için bu çalışmayı planladık.

YÖNTEM

Araştırma grubu

Çalışmamıza günlük yaşamında aktif olan, düzenli spor yapmayan, sağlıklı 47 erkek (35,02±10,11 yaş) ve 43 kadın (34,60±13,37 yaş), toplam 90 kişi gönüllü olarak katıldı. Gerekli kooperasyon ve kognitif becerilere sahip, son 1 yıl içinde herhangi bir sportif yaralanma veya operasyon geçirmemiş, alt ekstremite ve collumna vertebralis'e yönelik travma hikayesi olmayan, herhangi bir nörolojik problemi olmayan, Beden Kitle İndeksi (BKİ) 18-30 arası

olan, ölçüm öncesi ağır egzersiz yapmamış, alkol kullanmamış olan kişiler dahil edildi. Testlerin yapılmasını engelleyecek herhangi bir ortopedik engel taşıyan, en az 6 ay süren herhangi bir yaralanmaya bağlı ağrısı olan, düzenli egzersiz yapan, hamstring kas grubu ve m. gastrocnemius ve m. soleus kaslarında kısalık olan, yorgun olan kişiler dahil edilmedi. Katılımcılara bilgilendirilmiş onam formu imzalatıldı. Bu çalışma, Balıkesir Üniversitesi Tıp Fakültesi Klinik Araştırmalar Etik Kurulu'nun 09/06/2020 tarih ve 2020/90 numaralı etik kurul onayı ile gerçekleştirildi. Helsinki Bildirgesi'ne uygun hareket edildi. Ölçümler Balıkesir Üniversitesi Spor Bilimleri Fakültesi laboratuvarında, 2 Ağustos- 20 Ağustos 2021 tarihleri arasında yapıldı.

Araştırma Yöntemi

Antropometrik Ölçümler

Katılımcıların antropometrik ölçümleri (boy, kilo, femur uzunluğu) 1 mm'ye hassas mezura ile dokular sıkıştırılmadan sol ekstremiteden gerçekleştirildi. Femur uzunluğu ayakta dik duruş pozisyonundayken femur'un trochanter major'u ile tibia'nın condylus medialis'i arasındaki uzaklık ölçülerek hesaplandı (12). Kilo, ayakta dik duruş pozisyonunda, yüz karşıya bakacak şekilde TANITA BC-418 marka vücut analizi ölçüm cihazı ile yapıldı (13).

Fiziksel Aktivite Düzeyinin belirlenmesi

Kişilerin aktiflik düzeyi 2005 yılında Öztürk tarafından Türkçe'ye uyarlanmış Uluslararası Fiziksel Aktivite anketinin kısa formu (IPAQ) kullanılarak Metabolik Eşdeğer (MET) cinsinden hesaplandı (14,15). Çalışmaya 600 MET dk/hafta değerinin üzerinde; 601-3000 MET dk/hafta değerleri arasında orta düzey aktif ve 3001 MET dk/hafta ve üzeri aktif bireyler dahil edildi.

İzokinetik Kas Kuvveti Ölçümü

Diz fleksör ve ekstansör kas kuvveti IsoMed 2000 (D&R FerstlGmbH, Hemau, Almanya) cihazı kullanılarak gerçekleştirildi. Katılımcılara izokinetik değerlendirme öncesi 5 dk bisiklet ergometresini takiben 5 dk diz ekstensör ve fleksör kaslarına germe egzersizleri yapıldı. Ölçümü yapılacak kişinin cihaza göre uygun koltuk ayarları yapıldı. Kişinin sağ taraf uyluğu, pelvisi ve üst gövdesi bantlarla cihazın koltuğuna sabitlendi. Dinamometrenin pivot noktası femur'un lateral kondiline gelecek şekilde, kol ekseni ise kişinin bacak uzunluğuna paralel olacak şekilde ayarlandı. Ayrıca dinamometrenin uzun veya kısa olan kolları kişinin boyuna uygun olarak seçildi. Kişinin ayak bileğini cihaza sabitlemek amacıyla dinamometrenin aparatı ayak bileğini kavrayacak biçimde bantlandı. Dinamometreye diz ekleminin hareket açılığı 5° ile 90° arasında olacak şekilde iki stoper takıldı. Kuvvet yayılımını önlemek amacıyla hareket sırasında, kişiden ellerini çapraz omzuna götürmesi istendi (16). Her kişi için cihaz ayrıca kalibre edildi. İzokinetik kas kuvvet testi tek bacak için 60°/sn hızda 6 maksimal tekrar; 180°/sn hızda 20 maksimal tekrar olarak gerçekleştirildi. İki ölçüm arasında 90 sn dinlenme süresi verildi. Ölçümlerden önce kişiden deneme amaçlı ve cihaza adaptasyonu sağlamak açısından aynı hızlarda ve hareket açıklığında diz fleksiyon ve ekstansiyon hareketi yapması istendi. Ölçümler sırasında görsel ve işitsel biofeedback verildi (17,18,33).

Test sonucunda diz fleksör ve ekstansörleri için pik tork (PT), total iş (TW), pik tork/vücut ağırlığı (PT/VA), total iş/vücut ağırlığı (TW/VA), H/Q ve PT oluştuğu eklem hareket açısı değerlendirildi.

İstatistiksel analiz

Katılımcılardan elde edilen veriler SPSS (Statistical Package for Social Sciences, SPSS Inc., Chicago, Illinois, USA) 16.0 paket programında analiz edildi (19). Verilerin tanımlayıcı istatistik analizleri hesaplandı. Shapiro Wilk Testi ile normallik analizi yapıldı ve verilerin normallik varsayımına uyduğu görüldü. Cinsiyetler arasındaki farklılıklar Bağımsız Örneklem T testi ile karşılaştırıldı. Spearman's rho

Tablo 1. Katılımcıların Antropometrik Özellikleri ve Haftalık Toplam MET Değeri

	Kadın (n=43) Ort ± SS (Min - Maks)	Erkek (n=47) Ort ± SS (Min - Maks)	t	p
Yaş (yıl)	34,60±13,37 (18-60)	34,95±10,04 (20-53)	-0,165	0,869
Vücut ağırlığı (kg)	65,46±10,70 (45-85)	74,44±10,49 (52-92)	-4,018	**0,000***
Boy (cm)	162,08±5,66 (152-175)	173,23±7,37 (155-190)	-7,997	**0,000***
BKİ (kg/m²)	24,88±3,37 (18-30)	24,81±3,18 (18,42-30)	0,098	0,922
Femur boyu (cm)	43,93±3,65 (37,5-53)	46,25±3,60 (39-52,5)	-3,036	**0,003***
MET (ml/kg/dk)	1574±1098 (616,5-6072)	3040±2749 (622,5-11172)	-3,265	**0,001***

*p<0,05, Ort: Aritmetik Ortalama, SS: Standart Sapma, BKİ: Beden Kitle İndeksi MET: Metabolik Eşdeğer

korelasyon analizi kullanılarak femur boyu ile izokinetik test değişkenlerinin arasındaki ilişki değerlendirildi. Veriler ortalama ± standart sapma olarak ifade edildi. p değeri 0,05'ten küçük olan sonuçlar istatistiksel olarak anlamlı kabul edildi. Çalışmada örneklem hacmi grup 1 için 36, grup 2 için 36 olmak üzere toplamda 72 olarak hesaplandı. Örneklem hacmi hesaplanırken G*Power 3.1.9.4. paket programından yararlanıldı. Çalışmanın gücü 0,809, güvenilirliği 0,95, etki büyüklüğü ise 0,6 olarak belirlenmiş olup çalışmada grup 1 için 43, grup 2 için 47 denekten ilgili veriler toplandı (20).

SONUÇLAR

Vücut ağırlığı, günlük hayatta aktifliğin göstergesi olan MET değeri, boy ve femur uzunluğu erkeklerde anlamlı olarak daha yüksek bulundu (p<0,01) (Tablo 1).

Tablo 2. Diz Fleksör ve Ekstansörlerinin PT ve PT/VA Değerleri, TW ve TW/VA Değerleri, H/Q Oranı ve PT Oluşma Açısı

		Kadın (n=43) Ort ± SS (Min - Maks)	Erkek (n=47) Ort ± SS (Min - Maks)	t	p
60°/sn diz flex	**PT (Nm)**	52,51±11,39 (31-73)	100,68±20,88 (52-148)	-13,734	**0,000***
	PT/VA (Nm/kg)	0,81±0,19 (0,47-1,38)	1,35±0,24 (0,92-2,03)	-11,436	**0,000***
60°/sn diz ext	**PT (Nm)**	116,86±23,04 (73-205)	205,31±42,13 (115-310)	-12,494	**0,000***
	PT/VA (Nm/kg)	1,81±0,35 (1,20-2,76)	2,77±0,52 (1,97-4,30)	-10,347	**0,000***
180°/sn diz flex	**PT (Nm)**	39,44±8,50 (24-47)	78,10±24,94 (45-202)	-10,008	**0,000***
	PT/VA (Nm/kg)	0,61±0,16 (0,38-1,14)	1,04±0,28 (0,60-2,24)	-9,063	**0,000***
180°/sn diz ext	**PT (Nm)**	83,62±16,95 (51-144)	146,04±32,14 (85-229)	-11,657	**0,000***
	PT/VA (Nm/kg)	1,30±0,29 (0,85-1,86)	1,96±0,35 (1,42-2,95)	-9,534	**0,000***
60°/sn diz flex	**TW (J)**	296,79±69,96 (168,00-406,00)	566,63±124,57 (312,00-865,00)	-12,510	**0,000***
	TW/VA (J/kg)	4,63±1,25 (2,20-7,55)	7,64±1,55 (5,07-11,43)	-10,053	**0,000***
60°/sn diz ext	**TW (J)**	536,93±97,28 (366,00-748,00)	898,04±206,14 (468,00-1527,00)	-10,770	**0,000***
	TW/VA (J/kg)	8,32±1,62 (5,33-12,86)	12,04±2,13 (7,90-17,15)	-9,229	**0,000***
180°/sn diz flex	**TW (J)**	579,67±123,01 (291,00-861,00)	1151,06±326,88 (433,00-1854,00)	-11,151	**0,000***
	TW/VA (J/kg)	9,06±2,40 (4,47-14,59)	15,49±4,06 (5,14-24,04)	-9,226	**0,000***
180°/sn diz ext	**TW (J)**	1145,27±231,31 (484,00-1660,00)	2049,04±720,18 (1062,00-5863,00)	-8,156	**0,000***
	TW/VA (J/kg)	17,88±4,45 (8,34-27,05)	27,33±7,17 (16,64-63,72)	-7,421	**0,000***
60°/sn H/Q (Nm/kg)		0,45±0,06 (0,33-0,62)	0,49±0,07 (0,23-0,64)	-3,093	**0,003***
180°/sn H/Q (Nm/kg)		0,48±0,10 (0,30-0,75)	0,53±0,10 (0,33-0,95)	-2,416	**0,018***
60°/sn flex oluşma açısı (°)		38,4±9,2 (22,0-59,0)	38,0±8,1 (22,0-56,0)	0,218	0,828
60°/sn ext oluşma açısı (°)		62,6±4,2 (52,0-75,0)	64,8±4,3 (54,0-78,0)	-2,385	**0,019***
180°/sn flex oluşma açısı(°)		26,1±12,7 (11,0-50,0)	29,8±11,6 (11,0-50,0)	-1,448	0,151
180°/sn ext oluşma açısı (°)		70,0±7,3 (55,0-78,0)	69,2±8,1 (54,0-77,0)	0,455	0,650

*p<0,05, Ort: Aritmetik Ortalama, SS: Standart Sapma, PT: Pik Tork, PT/VA: Pik Tork/Vücut Ağırlığı, flex: fleksiyon, ext: extansiyon, H/Q: Hamstring kuvveti/Quadriceps kuvveti, TW: Total Work, TW/VA: Total Work/Vücut Ağırlığı

Hem diz fleksör ve ekstansör kas kuvveti hem de kas kuvvetinin vücut ağırlığına oranı erkeklerde daha yüksek bulundu (p<0,001). Kadın ve erkek arasında kuvvet farkının en fazla olduğu yer ise 180°/sn hızda diz fleksörleridir. Ayrıca diz eklemi yaralanmasını ve stabilizasyonunu ifade eden H/Q oranı her iki hızda da erkeklerde yüksek olduğu bulundu (p<0,01) (Tablo 2).

Belirlenen açıda eklem hareketi gerçekleşirken fleksör kaslar en fazla kuvveti eklem hareket açısının başında açığa çıkartmışlar, ekstansör kaslar ise eklem hareketinin sonuna doğru oluşturmuşlardır. Ayrıca açısal hızın artmasıyla fleksörlerin PT oluşma açısı azalırken, ekstansörlerin arttığı gözlendi. Cinsiyetler arasında ise 60°'de ekstansör kaslarda, 180°'de fleksör kaslarda PT oluşma açısında istatistiksel olarak anlamlı farklılık saptandı (p<0,01) (Tablo 2).

Diz fleksör ve ekstansörlerinin kas dayanıklılığı değeri ve bu değerin vücut ağırlığına oranının erkeklerde daha yüksek olduğu görüldü (p<0,001) (Tablo 2).

Femur uzunluğunun kadınlarda yaş, vücut ağırlığı, BKİ ile negatif korelasyon, boy ve MET değeri ile pozitif korelasyon olduğu görüldü (p<0,05). Erkeklerde ise femur uzunluğu ile boy arasında pozitif korelasyon bulundu (p<0,01) (Tablo 3).

Kas dayanıklılığı ve kas dayanıklılığının vücut ağırlığına oranı ile femur uzunluğu arasındaki korelasyon kadınlarda anlamlı düzeyde ilişkili bulunurken, erkeklerde sadece 60°/sn hızda anlamlılık görüldü (p<0,05) (Tablo 4).

Kas kuvveti ve kas kuvvetinin vücut ağırlığına oranı ile femur uzunluğu ilişkine bakıldığında, kadınlarda hem diz ekstansör kas kuvvetinin hem de bu kuvvetin vücut ağırlığına oranının femur uzunluğu ile

Tablo 3. Femur Uzunluğu ile Antropometrik Ölçümler Arasındaki İlişki

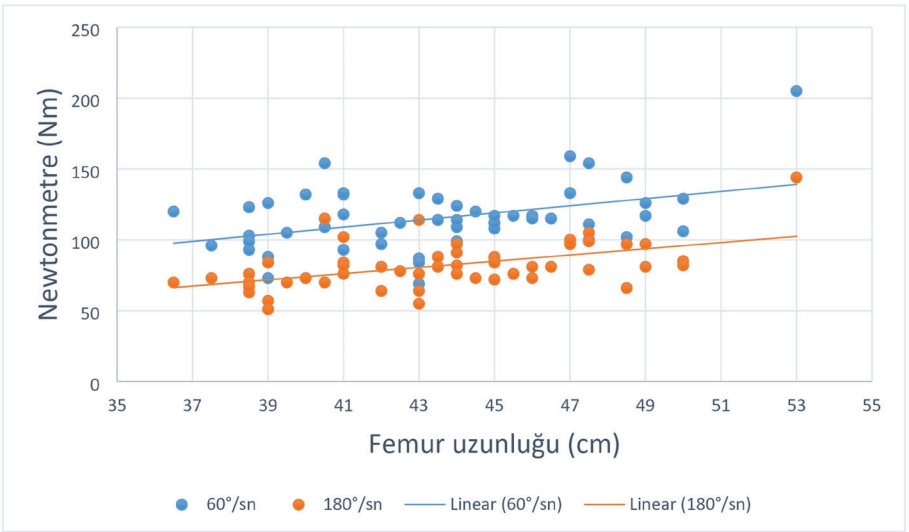
		Femur uzunluğu (cm)	
		Kadın (n=43)	**Erkek (n=47)**
Yaş (yıl)	**p**	**0,021***	0,202
	r	-0,351	-0,190
Vücut ağırlığı (kg)	**p**	0,215	0,052
	r	-0,193	0,285
Boy (cm)	**p**	**0,045***	**0,000***
	r	0,308	0,675
BKİ (kg/m²)	**p**	**0,036***	0,703
	r	-0,321	-0,057
Haftalık toplam MET değeri	**p**	0,141	0,405
	r	0,228	-0,124

*p<0,05, r: korelasyon katsayısı, BKİ: Beden Kitle İndeksi, MET: Metabolik Eşdeğer

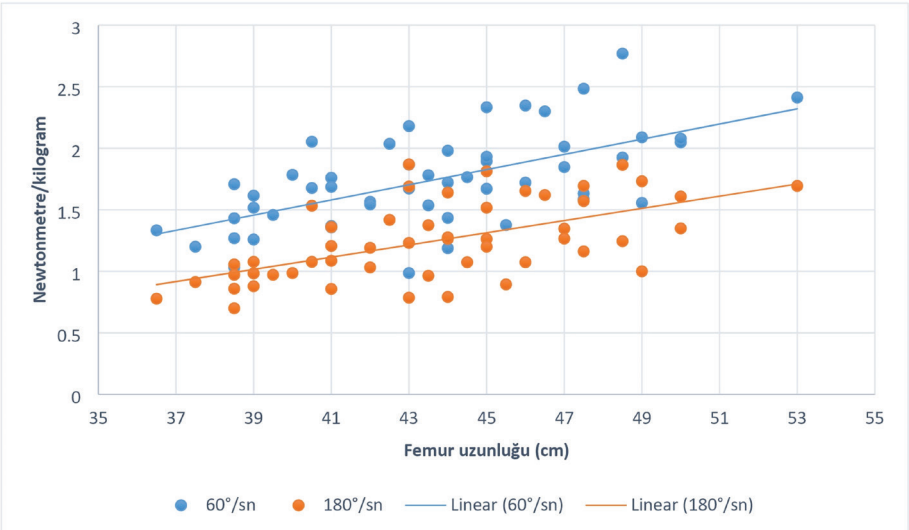
Tablo 4. Kas Dayanıklılığı ve Kas Dayanıklılığının Vücut Ağırlığına Oranı ile Femur Uzunluğu İlişkisi

Kas Dayanıklılığı Ölçümleri		**Femur uzunluğu Kadın (n=43)**		**Femur uzunluğu Erkek (n=47)**	
		60°/sn	**180°/sn**	**60°/sn**	**180°/sn**
Diz flex TW (J)	**p**	**0,002***	**0,029***	**0,037***	0,833
	r	0,467	0,334	0,305	0,032
Diz ext TW (J)	**p**	**0,002***	**0,017***	**0,018***	0,194
	r	0,457	0,363	0,344	0,193
Diz flex TW/VA (J/kg)	**p**	**0,000***	**0,015***	0,320	0,324
	r	0,512	0,368	0,148	-0,147
Diz ext TW/VA (J/kg)	**p**	**0,000***	**0,009***	**0,026***	0,317
	r	0,602	0,395	0,325	0,149

*p<0,05, r: korelasyon katsayısı, flex: fleksiyon, ext: extansiyon, TW: Total Work, TW/VA: Total Work/Vücut ağırlığı



Şekil 1. Kadınlarda 60°/sn ve 180°/sn Hızda Diz Ekstansör Kas Kuvveti ile Femur Uzunluğunun Pozitif İlişkisi.



Şekil 2. Kadınlarda 60°/sn ve 180°/sn Hızda Diz Ekstansör PT/VA ile Femur Uzunluğunun Pozitif İlişkisi.

pozitif korelasyon gösterdiği bulundu ($p<0,05$) (Şekil 1, Şekil 2). Erkeklerde ise anlamlılık bulunmadı ($p>0,05$).

TARTIŞMA

Çalışmamızda günlük hayatında aktif fakat düzenli spor yapmayan ve spor geçmişi olmayan yetişkin bireylerin diz fleksör ve ekstansör kas kuvveti, dayanıklılığı, H/Q oranı değerlendirildi. Kadınlarda kas dayanıklılığının ve ekstansör kas kuvvetinin femur uzunluğuna bağlı olarak artış gösterdiği bulundu. Erkeklerde ise kas kuvvetinden ziyade kas dayanıklılığı ile femur uzunluğu arasında pozitif ilişki tespit edildi. Bununla birlikte, kısa femur boyunun kas kuvveti açısından kadınlar için dezavantaj oluşturduğu ortaya konuldu.

Antropometri ve kas kuvvetini kıyaslayan çalışmalara bakıldığında aktif sporcularda (5-7,9), çocuklarda (11,21,8,24), femoral uzatma operasyonu sonrası kişilerde (16,26) karşılaştırmaların yapıldığı görülmektedir. Örneklem grubu yetersiz de olsa günlük yaşamında fiziksel olarak aktif olan ve olmayan bireylerde yapılan çalışmalar da vardır (10,23).

Kas kuvveti büyüme ve gelişmeye bağlı değişim göstermektedir. İstemli kas hareketleri sırasında

nöral kontrolün farklılığına bağlı olarak kas kuvveti cinsiyetler arasında ve yaş grupları arasında farklılık oluşturmaktadır. Bu farklılığı ortadan kaldırmak için kas kuvveti vücut ağırlığına bölünmekte yani kuvvetsel açıdan normalleştirilme yapılmaktadır. (22). Çocuklarda yetişkinlerden, kadınlarda ise erkeklerden daha düşük kuvvet üretme yeteneği vardır (4,23,31). Bizim çalışmamızda da erkeklerdeki hem kas kuvvet değeri hem de normalleştirme yapılmış kas kuvvet değeri daha yüksektir.

Herhangi bir egzersiz yapmayan 6-9 yaş arası çocuklarda ve orta derecede aktif veya sedanter 18-25 yaş arası yetişkinlerde çalışma yapan Kanehisa ve diğ. (1994), uyluk kas kuvvetini kas kesit alanı ile uyluk uzunluğunun çarpılmasıyla hesaplayarak antropometrinin kas kuvvetine etkisini ifade etmiştir (23). Bu etki yetişkinlerde daha fazladır. Çünkü yetişkinlerin çocuklara göre kas boyutuyla orantılı olarak kuvvet üretme yeteneği daha yüksektir ve çocukların ergenliğe kadar kas kuvveti ve antropometri uyumu beklenenden fazla artar. Yetişkinlerle yaptığımız bu çalışmada da kas kuvveti ve antropometri arasında pozitif ilişki bulunmuştur.

Antropometrik özellikler spor performansını etkileyen önemli faktörlerdendir. Özellikle çocuklarda ve adölesanlarda yetenekli sporcuların tespiti için önemlidir. Nevill ve diğ. (2015), 11-16 yaş arası yüzücülerde yaptığı çalışmada femur uzunluğunun yüzme hareketini değiştirerek alt ekstremitenin batmasına neden olup dezavantaj sağladığı, önkol ve ayak uzunluğunun ise daha iyi itiş sağlayıp avantaj oluşturduğunu ortaya koymuşlardır (8). Akşit ve diğ. (2017) ise 11-14 yaş arası yüzücülerde gövde ve ekstremite uzunluklarının erkeklerde daha yüksek olmak üzere her iki cinsiyet için de itme kuvveti üzerinde olumlu etkileri bulunduğunu ve yüzme performansını olumlu etkilediğini bulmuşlardır (24). Böylece uzun gövde ve ekstremiteye sahip bireylerin yüzme sporuna yönelmesi performans açısından avantaj sağlar.

Ferland ve diğ. (2020), 18-40 yaş arası, 59 erkek powerlift (squat, bench ve deadlift) sporcusunda antropometrik özellikleri ve performanslarını kıyasladığı çalışmada, uyluk uzunluğunun squat ve deadlift performansına pozitif katkı sağladığı, bench performansına ise etki etmediğini tespit etmişlerdir. Bulgular sonucunda antropometrik özelliklerin sporcunun kuvvetinin tahmin edilebilmesi için iyi bir gösterge olduğu ortaya çıkmıştır. Bununla birlikte kas kuvvetinde, sadece fizyolojik temelli adaptasyonların değil uyluk boyu gibi biyomekaniksel faktörlerin de önemli olduğunu belirtmişlerdir (9). Sonuç olarak kişiye özel egzersiz programları düzenlenirken biyomekanik faktörler de göz önünde bulundurulmalıdır.

Femoral uzatma ameliyatı sonrası yapılan bir çalışmada, ameliyat sonrası kas kuvveti değerinde quadricepste %40-50, hamstringte %15-20 kuvvet kaybı ortaya çıkmış fakat sonrasında egzersizle kas kuvvetinin eski haline döndüğü gözlenmiştir (23). Krieg ve diğ. (2018) femoral uzatma ameliyatı öncesi ve sonrası uzun ve kısa ekstremitelerin diz ekstansör ve fleksör kas kuvvetlerini kıyaslamışlardır. Ameliyat öncesinde iki bacak arasında ekstansörlerde fark %15 iken ameliyat sonrasında bu fark %22'ye yükselmiştir. Diz fleksörlerinde ise belirgin değişiklik görülmemiştir. Bunun nedenini ise hastaların geliştirdikleri diz fleksiyon mekanizması sonucu ekstansörlere daha fazla yük bindirmeleri olarak açıklamışlardır (26). Yani uzatma ameliyatlarında etkilenen kasların morfolojisi ve kuvvetinde önemli değişiklikler oluşur. Antropometrinin değişmesi kas kuvvetine etki eder. Biz de bu çalışmayla antrpometrinin kas kuvvetine etkisini ortaya koyduk.

Diz ameliyatı geçiren hastalarda ameliyat öncesi ve sonrası kas kuvveti değerlerini femur uzunluğuyla kıyaslayan Dean ve diğ. (2022), kuvvetsel açığın femur uzunluğuyla negatif ilişkisi bulunduğunu söylemişlerdir. Yani daha uzun ekstremiteye sahip hastalar ya kuvvet açığını hızla kapatabilmekte ya da ameliyat öncesi kuvvetlerini büyük ölçüde koruyabilmektedirler. Ayrıca ameliyat edilmeyen ekstremitenin de kas kuvvetinin femur uzunluğuyla anlamlı ilişkisi olduğunu ortaya koymuşlardır. Bu sonuçlardan hareketle spesifik kemik morfolojik özelliklerinin kuvvet değişkenini etkileyebileceğini ve verilen egzersiz reçetelerinin bireyselleştirilmesi gerektiği önerisinde bulunmuşlardır (16).

Alt ekstremite uzunluk ile kuvvet arasındaki ilişkiyi değerlendiren çalışmaların yanı sıra üst ekstremite uzunluğu ile el fleksör-ekstansör kas kuvveti ve el kavrama kuvvetini ilişkilendiren çalışmalar da mevcuttur. Pizzigalli ve ark. (2016) İtalyan basketbolcularda yaptığı çalışmada ön kol uzunluğu ile kavrama kuvvetinin pozitif korele olduğunu göstermişlerdir (26). Alahmari ve diğ. (2017) ise Araplarda yaptığı

çalışmada el uzunluğunun kavrama kuvvetini olumlu etkilediğini tespit etmişlerdir (28). Elit ve rekreasyonel spor tırmanışçılarında yer değiştirmek ve dengeyi sağlamak için üst ekstremitenin yanında eller ve parmaklar da oldukça fazla kullanılmaktadır ve bu nedenle kavrama kuvveti tırmanmada önemlidir. Uzun parmaklar ve eller kavrama kuvvetini pozitif etkilemekte ve daha verimli ve etkili kavrama yapılabilmesini sağlamaktadır. Yani başarılı tırmanma performansı için belirli antropometrik özellikler olmalıdır (29). Parmak uzunluğu, el uzunluğu, ön kol uzunluğu gibi pratik ölçülebilen antropometrik özellikler ile kas kuvveti ve tırmanma başarısı tahmin edilebilir. Aynı durumun alt ekstremite için de geçerli olduğunu yaptığımız çalışma ile ortaya koyduk.

Bhat ve diğ. (2021), 18-35 yaş arası, 7 farklı ırk üzerinde yaptığı çalışmada kol, ön kol, el uzunluğu ve tüm parmak uzunluklarıyla el kavrama kuvvetinin pozitif ilişki gösterdiğini belirtmiştir. Ayrıca antropometrik özelliklerin ve el kavrama kuvvetlerinin her ırkta farklılık gösterdiğini ortaya koymuştur. Hatta belli bir nüfusta siviller, askeri personel, öğrenciler, işçiler arasında bile farklılıklar vardır ve birçok ülke bu farklılıklar ile bir veritabanı oluşturmayı amaçlamışlardır (30). Biz de çalışmamızla Türk popülasyonunda düzenli spor yapmayan fakat aktif olan kişilerin kas kuvvetinin referans değerlerine katkı sağlamayı amaçladık.

Erkek ve kadınlarda ergenlik sonrasında quadriceps ve hamstring güç profilleri farklılık gösterir. Olgunlaşmayla birlikte erkeklerde hamstring kas kuvvetinde artış görülürken kadınlarda nöromuskuler dengesizliklerden dolayı erkekler kadar artış görülmez ve yaralanma riski artar. (4,31). Quadricepse göre azalan hamstring kuvveti (H/Q), alt ekstremite yaralanmalarının yüksek insidansı ile ilişkilidir (32). Kuvvet farkından meydana gelen yaralanmaları önlemek için diz ekleminin biyomekaniğini anlamak önemlidir. Hareket sırasında kasların maksimum kuvveti ürettiği açı burada önem kazanmaktadır. Bu açı, açısal hıza göre değişkenlik gösterir, kadın ile erkek arasında kuvvetsel farkların oluşmasına neden olabilir. Çalışmamızda cinsiyetler arasında 60°/sn hızda diz ekstansörlerinde pik torkun ortaya çıktığı açıdaki anlamlı farklılık, kuvvetsel anlamda da belirgin farklılığın ortaya çıkmasını sağlamıştır (33).

Kas kuvvetiyle paralellik gösteren dayanıklılık da yine günlük yaşamda aktif kullanılan ekstansörlerde daha yüksektir. Rüst ve diğ. (2012) dayanıklılığı yüksek sporcular olan triatletlerde ve bisikletçilerde yaptığı antropometrik ölçümlerde daha az iskelet kasına sahip triatletlerde alt ekstremite uzunluğunun daha kısa olduğunu tespit etmişlerdir. Fakat bu kısalığın triatletler için dezavataj oluşturmadığını bulmuşlardır (34). Ayrıca Ogueta-Alday ve diğ. (2018) yarı maroton koşan sporcularda, uyluk uzunluğunun koşu performansını üzerinde etkisinin bulunmadığını ortaya koymuşlardır (35). Biz çalışmamızda femur boyunun kas dayanıklılığına etkisi olduğunu bulduk. Sonuçlarımızın diğer çalışmalar ile farklılık göstermesinin nedeni profesyonel sporcular yerine fiziksel olarak aktif bireyler üzerinde ölçümlerin yapılmasından kaynaklanabilir.

Örneklem sayısının az olması, sporcu grup ile sonuçların kıyaslanamaması, iki ekstremitenin birlikte değerlendirilememesi çalışmanın kısıtlılıklarıdır.

Çalışmamızda diz fleksör ve ekstansör kas kuvvetinin femur boyu ile ilişkili olduğu sonucuna varılmıştır. Femur boyunun kişiye kuvvet ve dayanıklılık açısından avantaj sağladığı görülmektedir. Bu nedenle kişinin ekstremite antropometrik ölçümlerine bakılarak kas kuvveti ve dayanıklılığı değerlendirilebilir ve bununla birlikte kişiye özel egzersiz programında femur boyunun göz önüne alınmasının faydalı olabileceği kanaatine varılmıştır.

Destekleyen Kuruluş: Bu çalışma Balıkesir Üniversitesi 2020/092 proje numaralı BAP ile desteklemiştir.

Çıkar Çatışması: Yazarlar, herhangi bir çıkar çatışması beyan etmemektedir.

Yazar Katkıları: Fikir/Kavram-BA; Tasarım-ÖK, ZP; Denetleme/Danışmanlık- ÖK, ZP, EÖ; Kaynaklar ve Fon Sağlama- BA, ZP, ÖK, EÖ; Materyaller- BA, ZP, ÖK, EÖ; Veri Toplama ve/veya İşleme-BA, ZP; Analiz ve/veya Yorumlama-BA, ZP, ÖK, EÖ, İK; Literatür Taraması- BA, ZP, ÖK, EÖ; Makale Yazımı- BA, ZP, ÖK, EÖ; Eleştirel İnceleme- ÖK, ZP, EÖ, İK.

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THE ACUTE EFFECT OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON CERVICAL RANGE OF MOTION, STRENGTH, AND PROPRIOCEPTION

ORIGINAL ARTICLE

ABSTRACT

Purpose: This double-blind randomized controlled study aimed to investigate the acute influence of two different proprioceptive neuromuscular facilitation (PNF) exercise, targeting stretching and strengthening, on cervical proprioception, range of motion (ROM) and strength among healthy university students.

Methods: Healthy subjects were randomly divided into three groups as PNF stretching (PNFS) (n=36), resistive PNF pattern (PNFP) (n=35), and control group (CG) (n=33) which received only passive range of motion (ROM) exercises without causing any stretch. All participants were assessed in terms of cervical proprioception, ROM and muscle strength before and after one intervention session.

Results: Within-group analysis of the PNFS group showed a significant difference only in extension proprioception and right rotation ROM ($p \leq 0.05$) while the PNFP group showed a significant difference in extension, right rotation, right and left lateral flexion proprioception; extension and right rotation ROM, and right and left rotation muscle strength ($p \leq 0.05$). For the CG, the within-group analysis showed a significant difference in flexion, extension, right rotation and right lateral flexion proprioception, extension, and left and right lateral flexion ROM ($p \leq 0.05$). Between-group analysis showed a significant difference only in cervical flexion proprioception ($p=0.023$) for PNFP over the CG.

Conclusion: Although a lack of significant difference found in the between-group analysis, the within-group analysis showed that PNF patterns applied with resistance may be a promising technique to improve cervical proprioception, muscle strength and ROM.

Keywords: Cervical spine, Proprioception, Proprioceptive neuromuscular facilitation, Range of motion, Strength.

PROPRİOSEPTİF NÖROMUSKÜLER FASİLİTASYONUN SERVİKAL EKLEM HAREKET AÇIKLIĞI, KUVVET VE PROPRİYOSEPSİYON ÜZERİNE AKUT ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu randomize kontrollü çift kör çalışmada, sağlıklı üniversite öğrencilerinde uygulanan, germe ve güçlendirmeyi hedefleyen iki farklı propriyoseptif nöromüsküler fasilitasyon (PNF) egzersizinin servikal propriyosepsiyon, eklem hareket açıklığı (EHA) ve kas kuvveti üzerindeki akut etkisinin araştırılması amaçlanmıştır.

Yöntem: Sağlıklı denekler rastgele olarak PNF germe (PNFG) (n=36), dirençli PNF paterni (PNFP) (n=35), ve herhangi bir gerilmeye neden olmadan sadece pasif EHA egzersizleri uygulanan kontrol grubu (KG) (n=33) olmak üzere üç gruba ayrıldı. Tüm katılımcılar bir müdahale seansından önce ve sonra servikal propriyosepsiyon, EHA ve kas gücü açısından değerlendirildi.

Sonuçlar: PNFS grubu sadece ekstansiyon propriyosepsiyonu ve sağ rotasyon EHA'sında anlamlı bir fark gösterirken ($p \leq 0,05$), PNFP grubunun grup içi analizi ekstansiyon, sağ rotasyon, sağ ve sol lateral fleksiyon propriyosepsiyonu; ekstansiyon ve sağ rotasyon EHA'sı ile sağ ve sol rotasyon kas kuvveti açısından anlamlı bir fark gösterdi ($p \leq 0,05$). KG için, grup içi analizde fleksiyon, ekstansiyon, sağ rotasyon ve sağ lateral fleksiyon propriyosepsiyonu ile ekstansiyon ve sol ve sağ lateral fleksiyon EHA'sında anlamlı bir fark bulundu ($p \leq 0,05$). Gruplar arası analizde ise yalnızca PNFP grubu KG'ye göre servikal fleksiyon propriosepsiyonunda anlamlı bir fark gösterdi ($p=0,023$).

Tartışma: Gruplararası karşılaştırmada anlamlı fark bulunamamış olsa da, yapılan grup içi değerlendirmeler dirençle uygulanan PNF paternlerinin servikal propriyosepsiyon, kas gücü ve ROM'u iyileştirmek için umut verici bir teknik olabileceğini göstermiştir.

Anahtar Kelimeler: Servikal omurga, Propriyosepsiyon, Propriyoseptif nöromüsküler fasilitasyon, Eklem hareket açıklığı, Kuvvet.

INTRODUCTION

The cervical spine is responsible for providing enough stability for the head (1). Because it is the most mobile region of the spine with the ability to move in all plans of motion, the cervical spine is vulnerable to injury among all populations (2,3). Its sensorimotor control includes the integration and processing of all the visual, vestibular, and proprioceptive information (1). If there is an alteration in one of these systems, especially in the proprioceptive system, it results in many problems linked to the musculoskeletal system such as pain and functional disability (4,5).

Proprioception is the ability to sense the information raised from the musculoskeletal system regarding the movement and position of body parts in space (6). Disturbed proprioceptors have a negative influence on feedback and feedforward motor control. Moreover, they cause a decrease in alpha motor neuron drives and balance, and an increase in visual movement error when their functioning is improper (7). Because the cervical spine has a very delicate proprioceptive system to control posture and balance (1), it is extremely important to be sure that this system is functioning perfectly. In this way, future injuries and pain syndromes may be prevented and functional movement may be maximized.

Proprioceptive neuromuscular facilitation (PNF) is a treatment approach that develops and restores the proper functioning of joints and related structures by using neurological reflexes (8). It can also be defined as a method that influences neuromuscular processes by stimulating proprioceptors (9). PNF is concerned with motor unit activation and firing rate by using neural mechanisms that contribute to neural adaptation (10). Literature supports that because the PNF patterns are performed as large dynamic movements, they help to contract the muscles functionally. Thus, in addition to proprioception, they may increase strength, motor control, coordination and ROM (11).

Several studies are searching for the effectiveness of various PNF applications on different regions and health conditions. These studies have mainly compared the effectiveness of PNF stretching with other stretching methods (12–14). Also, some studies use PNF patterns for strengthening the muscles or increasing motor control (11,15). As far as we know, there is no study in the literature comparing the effectiveness of PNF stretching and PNF strengthening on cervical proprioception.

The primary aim of this study is to investigate the differences between one session PNF stretching and one session PNF strengthening applied to the cervical region on cervical proprioception (CP). Secondly, because of the potential effectiveness of the PNF on increased ROM and muscle strength, PNF stretching and strengthening were aimed to be compared in terms of cervical range of motion (ROM) and cervical muscle strength (MS). We hypothesized that even one session of PNF applications may be effective in increasing the CP, ROM and MS among university students.

METHOD

This double-blinded randomized controlled trial with a parallel design was conducted in Bahçeşehir University Physiotherapy and Rehabilitation Laboratories between June 2019 and July 2019. It was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Medical Ethics Committee of Medical, Surgical and Drug Researches of Yeditepe University Medical Faculty (Decision no: 1028). It was also registered in the ClinicalTrials.gov (NCT04045106).

The inclusion criteria were (1) having a score of 5 or less on the Neck Disability Index, (2) having no history of cervical trauma, diseases or syndrome, (3) having no history of surgeries to the neck, face, shoulders, (4) having no history of cancer or systemic diseases, (5) being 18 or older, (6) being able to understand and follow the instructions.

All the students in the university were invited to the study. 158 students accepted to be assessed and 54 of them were excluded from the study because of the mismatch in the inclusion criteria (Figure 1). 104 participants were randomly divided into three groups as PNF Stretching (PNFS) (n=35), PNF Pattern (PNFP) (n=36) and Control (CG) (n=33). Randomization was done by a person external to the study, by using a computer-based randomizer to generate a simple randomized list. This list was

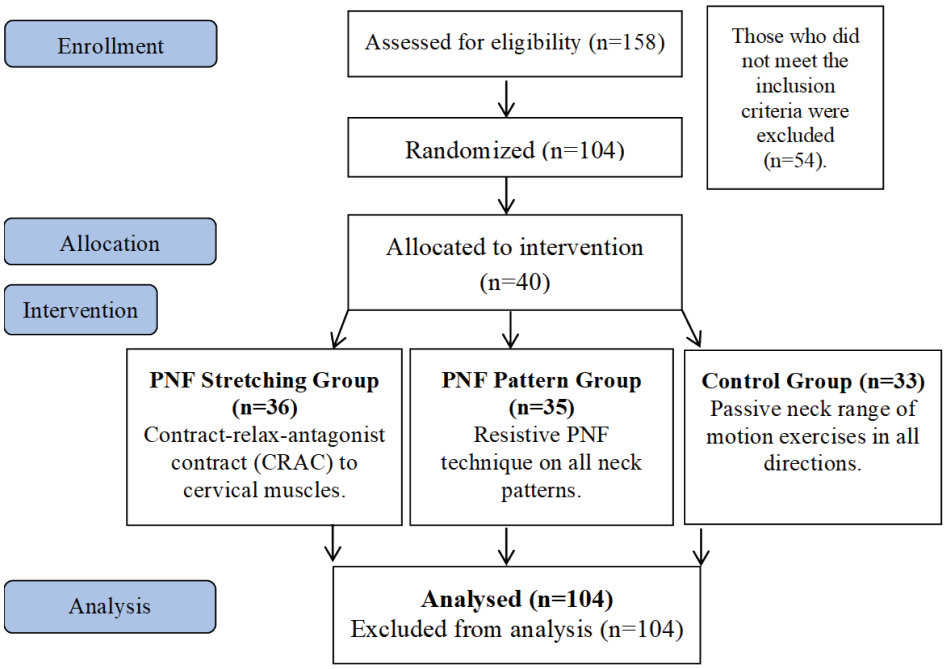

Figure 1. Flow Chart of Participants Allocation and Randomization

kept in a password-protected tablet, only the therapist who performed the intervention had access to the list. All the participants and the assessor therapist were blind to the groups. The informed consent was taken from all participants who met the inclusion criteria. They were assessed at the beginning by the blind assessor. Then the intervention was applied by another therapist according to the group in which the patient was involved. The intervention was performed in a separate room and the participants were not allowed to see each other. After the application, the second assessment was performed by the same, blind assessor.

Assessments

The demographic data were collected face-to-face with a structured questionnaire prepared by the researcher. The questionnaire included the age, weight, height and gender of the participants.

CP was assessed by using the Cervical Range of Motion Instrument (CROM, Performance Attainment Associates, Lindstrom, MN, USA) which was reliable and valid to assess CP (16–18). CP was assessed in flexion, extension, right and left lateral flexion, and right and left rotation. Participants were asked to sit and put on the CROM on the head. They were instructed to start moving their head to one of the directions. The assessor stopped them at the target angle which is 30 degrees and told them to feel the amount of movement and muscle tension. This was repeated 3 times as a reference, then they were asked to do the same procedure 3 times without the guidance of the therapist with the eyes closed until they reached the target angle. Deviation from the target angle was recorded as the test result.

Active range of motion (AROM) was measured by using the CROM instrument. AROM was taken for flexion, extension, right and left lateral flexion, and right and left rotation. The validity and reliability of CROM to assess ROM is well documented in the literature. Subjects were asked to sit on a chair during the measurement and they were first asked to look straight ahead, then to move the head as far as they can in the direction to be tested. For flexion and extension sagittal plane inclinometer was used; for lateral flexions frontal plane inclinometer was used and for rotations, a transverse plane inclinometer was used. Each measurement was repeated three times and the final position was recorded for each trial (19,20).

MS was taken by a myometer device (MicroFET2™ Hoggan Health Industries, Inc, West Jordan, Utah).

Subjects were positioned sitting on a chair. Cervical strength tested in 6 different positions isometrically. Resistance was applied (1) to the forehead for forward flexion (2) to occiput for extension (3) above the ear for right and left lateral flexion and (4) along the jaw near the chin for right and left rotation (21).

Interventions

Contract-relax-antagonist contract (CRAC) technique was applied to cervical flexors, extensors, right and left lateral flexors and right and left rotators to the participants in the PNFS group. For the application, the starting position was the neutral head position for all target muscle groups. According to the target muscle group, the head was moved to the stretching position of that muscle and at the end of the range, maximal voluntary isometric contraction was asked for 6 seconds. After the relaxation, the head was moved to the new range. The technique was applied 6 times for each muscle group with 1-2-minute rest was given before changing the target muscle group (22,23).

PNF strengthening was applied by using the resistive PNF patterns to the participants in the PNFP group. The participants were asked to sit on a chair. The therapist showed all of the 4 neck patterns (8). Then all the patterns were performed resistively as 3 sets of 10 repetitions with 1-2-minute rest between sets. The level of resistance was set as "optimal" to let the participant complete the pattern without any cessation of the movement or any pain. Participants were told to keep breathing normally and to report any discomfort and/or pain.

Participants allocated to the CG received passive ROM (PROM) to keep the participants blinded to group allocation. Flexion, extension, right and left lateral flexion, and right and left rotation were performed passively for 10 repetitions. It was done from a neutral position to the limit of motion without causing any stretch to the muscle.

Statistical Analysis

Statistical analysis was done by Statistical Package Analyze for Social Sciences (SPSS) version 26.0 for Windows (Armonk, NY: IBM Corp). The level of significance was accepted as $p \leq 0.05$. The variables were analyzed using probability plots and Kolmogorov-Smirnov Test to test the normality of the distribution. Descriptive analysis was presented with median, minimum, maximum, mean and standard deviation (SD), and frequency tables for the nominal variable. The Kruskal-Wallis test was used to compare the groups and significant results were analyzed by Mann-Whitney-U Test with Bonferroni correction to observe the pairwise differences. Nominal variables were analyzed by Chi-Squared Test and within-group analysis was done by Wilcoxon Signed Rank Test.

Table 1. Characteristics of Groups (n=104)

		PNFS (n=36)	PNFP (n=35)	CG (n=33)	p
Age (Years)	Median (Min-Max)	21.50 (19-28)	22 (20-28)	21 (19-26)	0.115
	Mean±SD	22.472.56±	22.372.13±	21.362.64±	
Height (m)	Median (Min-Max)	1.70 (1.50-2.05)	1.70 (1.55-1.87)	1.70 (1.57-1.93)	0.850
	Mean±SD	1.72± 0.10	1.710.08±	1.710.10±	
Weight (kg)	Median (Min-Max)	66 (46-107)	66 (50-117)	65 (40-120)	0.721
	Mean±SD	68.8317.33±	68.9114.38±	66.7017.49±	
BMI (kg/m²)	Median (Min-Max)	22.31 (15.92-35.83)	23.12 (18.47-33.82)	21.72 (16.02-35.06)	0.700
	Mean±SD	23.154.50±	23.393.63±	22.664.41±	
		PNFS (n=36)	**PNFP (n=35)**	**CG (n=33)**	**p***
Gender	Female n (%)	20 (55.6)	22 (62.9)	23 (69.7)	0.479
	Male n (%)	16 (44.4)	13 (37.1)	10 (30.3)	

p: Kruskal Wallis-H Test, p*: Chi-Squared Test, BMI: Body Mass Index; CG: Control Group; kg: kilogram; m: meter; Min-Max: Minimum-Maximum; n: Number; PNFS: Proprioceptive Neuromuscular Facilitation Stretching Group; PNFP: Proprioceptive Neuromuscular Facilitation Pattern Group; SD: Standard Deviation, %: Percentage.

Table 2. Cervical Proprioception Before and After Intervention Within Each Group and Between Groups

	Base	PNFS (n= 36)			PNFP (n= 35)				CG (n= 33)				Diff
	p*		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**	p*
Flexion	0.059	pre	2 (0 – 8)	-0.612.98±	0.270	pre	2 (0 – 10)	0.11±2.83	0.648	pre	4 (0 – 10)	-2.003.46±	**0.004***	**0.020***
		post	1 (0 – 4)			post	2 (0 – 10)			post	0 (0 – 4)			
Extension	0.653	pre	2 (0 – 12)	-1.503.26±	**0.010***	pre	2 (0 – 6)	-0.972.24±	**0.018***	pre	2 (0 – 12)	-1.33±2.81	**0.014***	0.899
		post	0 (0 – 10)			post	0 (0 – 6)			post	2 (0 – 6)			
Right LF	0.699	pre	2 (0 – 8)	-0.893.22±	0.065	pre	4 (0 – 10)	-1.43±2.73	**0.005***	pre	4 (0 – 8)	-1.45±2.93	**0.010***	0.846
		post	2 (0 – 10)			post	2 (0 – 6)			post	2 (0 – 6)			
Left LF	0.399	pre	2 (0 – 6)	0.173.00±	0.728	pre	2 (0 – 8)	-1.312.17±	**0.001***	pre	2 (0 – 9)	-0.762.61±	0.104	0.058
		post	2 (0 – 6)			post	0 (0 – 6)			post	2 (0 – 6)			
Right Rotation	0.732	pre	2 (0 – 16)	-0.674.51±	0.465	pre	2 (0 – 10)	-1.60±3.28	**0.011***	pre	2 (0 – 10)	-1.883.16±	**0.002***	0.420
		post	2 (0 – 18)			post	2 (0 – 6)			post	0 (0 – 6)			
Left Rotation	0.149	pre	2 (0 – 12)	-0.943.50±	0.189	pre	2 (0 – 8)	-0.512.58±	0.295	pre	2 (0 – 10)	-0.853.08±	0.132	0.944
		post	2 (0 – 12)			post	2 (0 – 8)			post	2 (0 – 10)			

p*: Kruskal Wallis-H Test, p**: Wilcoxon Signed Rank Test, Base: Baseline Comparison, CG: Control Group; Diff: Between Group Difference; LF: Lateral Flexion; PNFS: Proprioceptive Neuromuscular Facilitation Stretching Group; PNFP: Proprioceptive Neuromuscular Facilitation Pattern Group; post: After the study; pre: Before the study; SD: Standard Deviation, Δ: Within-group difference.

RESULTS

This study included 104 healthy participants (65 female, 39 male; 36 PNFS, 35 PNFP, and 33 CG). No adverse effect was reported in any group. The study ended when completing all assessment parameters of all voluntary subjects. The power of the study was calculated by using G*Power 3.1.7 for Windows (G*Power©, University of Dusseldorf, Germany). Analysis results of cervical flexion proprioception were used to calculate the power. The calculated effect size (eta square) was 0.113 and the power of the study was calculated as 0.90. There was no significant difference between the groups according to the demographical characteristics of the groups (p>0.05) as shown in Table 1. Before the intervention, there was no significant difference between groups in CP, ROM and MS in all movement directions (p>0.05).

The deviation from the target angle before and after the intervention for each movement direction was compared within and between groups (Table 2). There is a significant improvement in proprioception during only extension in the PNFS group (p=0.010) while it improved in most of the directions in the PNFP group and CG significantly (p<0.05). There was a significant difference in flexion proprioception sense between groups (p=0.020). A pairwise comparison done with Bon-

Table 3. Cervical ROM Before and After Intervention Within Each Group and Between Groups

	Base	PNFS (n= 36)			PNFP (n= 35)				CG (n= 33)				Diff
	p*		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**	p*
Flexion	0.643	pre	62 (40 – 80)	2.33±7.91	0.130	pre	58 (38 – 84)	1.777.06±	0.245	pre	60 (48 – 80)	0.736.70±	0.473	0.871
		post	66 (46 – 80)			post	60 (40 – 82)			post	60 (46 – 80)			
Extension	0.638	pre	66 (50 – 82)	1.147.79±	0.498	pre	70 (40 – 80)	3.717.36±	**0.009***	pre	66 (42 – 90)	1.945.78±	**0.037***	0.579
		post	70 (48 – 84)			post	70 (46 – 88)			post	68 (50 – 82)			
Right LF	0.497	pre	46 (32 – 64)	0.535.68±	0.407	pre	44 (32 – 60)	-0.294.95±	0.771	pre	44 (32 – 70)	1.885.02±	**0.020***	0.197
		post	47 (34 – 60)			post	44 (34 – 58)			post	46 (34 – 60)			
Left LF	0.447	pre	47 (34 – 58)	0.864.63±	0.295	pre	46 (34 – 56)	0.914.48±	0.093	pre	44 (32 – 64)	2.365.11±	**0.014***	0.283
		post	46 (34 – 60)			post	44 (36 – 56)			post	46 (38 – 68)			
Right Rotation	0.739	pre	70 (52 – 84)	2.926.72±	**0.022***	pre	70 (54 – 84)	3.606.32±	**0.003***	pre	70 (60 – 80)	1.886.08±	0.118	0.413
		post	70 (60 – 84)			post	72 (60 – 84)			post	72 (54 – 82)			
Left Rotation	0.872	pre	70 (50 – 80)	1.836.68±	0.089	pre	70 (54 – 82)	0.945.46±	0.405	pre	70 (60 – 80)	1.395.76±	0.150	0.710
		post	70 (60 – 84)			post	70 (50 – 82)			post	70 (60 – 80)			

p*: Kruskal Wallis-H Test, p**: Wilcoxon Signed Rank Test, Base: Baseline Comparison, Base: Baseline Comparison, CG: Control Group; Diff: Between Group Difference; LF: Lateral Flexion; PNFS: Proprioceptive Neuromuscular Facilitation Stretching Group; PNFP: Proprioceptive Neuromuscular Facilitation Pattern Group; post: After the study; pre: Before the study; SD: Standard Deviation; Δ: Within-group difference.

Table 4. Cervical Muscle Strength Before and After Intervention Within Group and Between Groups

	Base		PNFS (n= 36)				PNFP (n= 35)				CG (n= 33)			Diff
	p*		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**		Median (Min – Max)	Δ	p**	p*
Flexion	0.951	pre	12.90 (6.2 – 26.9)	0.142.93±	0.918	pre	11.30 (6.1 – 22.3)	0.072.22±	0.881	pre	11.10 (4.7 – 21.2)	0.612.03±	0.070	0.467
		post	12.25 (6.1 – 31.5)			post	13.10 (7.1 – 24.5)			post	12.50 (6.8 – 24.5)			
Extension	0.939	pre	18.95 (7.8 – 34.2)	-0.053.64±	0.869	pre	18.40 (9.1 – 44.8)	0.673.60±	0.151	pre	18.50 (8 – 31.4)	0.653.32±	0.304	0.541
		post	19.10 (10.1 – 26.2)			post	19.5 (10.1 – 34.4)			post	19.80 (10.5 – 30)			
Right LF	0.800	pre	17.80 (7 – 29.1)	0.333.25±	0.372	pre	17.80 (8.1 – 33.3)	0.423.32±	0.426	pre	16.40 (7.6 – 28.4)	0.522.48±	0.131	0.907
		post	17.05 (9.9 – 31.9)			post	18.3 (10.1 – 31.5)			post	17.20 (9.7 – 32.3)			
Left LF	0.576	pre	17.05 (7.1 – 30.9)	0.253.63±	0.718	pre	17.60 (7 – 32.6)	0.393.86±	0.694	pre	15.30 (7 – 30.4)	0.722.98±	0.114	0.681
		post	16.50 (8.8 – 32.9)			post	17.60 (8.3 – 32.1)			post	16 (9.7 – 27.3)			
Right Rotation	0.197	pre	12.30 (7.6 – 20.2)	0.003.09±	0.795	pre	11.70 (7 – 19.9)	1.212.28±	**0.005***	pre	11.40 (6 – 19)	0.53±1.79	0.126	0.052
		post	12.45 (9.6 – 25.1)			post	12.60 (8.3 – 20.1)			post	11.70 (6.8 – 18.2)			
Left Rotation	0.758	pre	12 (7.3 – 21.1)	0.372.76±	0.514	pre	11.5 (7.4 – 37.6)	0.545.19±	**0.005***	pre	11.50 (5.5 – 22.4)	0.15±1.88	0.242	0.112
		post	12.5 (8.1 – 28.5)			post	12.40 (7.3 – 19.1)			post	11.40 (6.8 – 21.6)			

p*: Kruskal Wallis-H Test, p**: Wilcoxon Signed Rank Test, Base: Baseline Comparison, CG: Control Group; Diff: Between Group Difference; LF: Lateral Flexion; PNFS: Proprioceptive Neuromuscular Facilitation Stretching Group; PNFP: Proprioceptive Neuromuscular Facilitation Pattern Group; post: After the study; pre: Before the study; SD: Standard Deviation; Δ: Within-group difference.

ferroni correction showed a significant difference between PNFP-CG (p=0.017) but not between PNFS-CG (p=0.269) and PNFS-PNFP (p=0.799).

Within-group and between group analysis of ROM improvement showed in Table 3. In PNFS group, only right rotation was improved significantly (p=0.022). In PNFP group, both the extension (p=0.09) and right rotation (p=0.003) were improved significantly. CP group showed significant improvements in extension (p=0.037), right lateral flexion (p=0.020) and left lateral flexion (p=0.014). According to between-group analysis, there was no significant difference between groups in ROM in all movement directions (p>0.005).

The comparison of the improvement in MS within and between groups is shown in Table 4. When the MS analysis results were examined, there was no significant improvement in both CG and PNFS groups in any movement directions (p>0.005). The PNFP group showed a significant difference in right (p=0.005) and left rotation (p=0.005), whereas the rest of the movement directions showed no significant difference (p>0.005). The between-group analysis showed no significant difference (p>0.005).

DISCUSSION

The aim of the study was to compare the acute effects of PNF stretching and PNF strengthening on CP, ROM and MS among healthy university students. According to the results, PNF strengthening applied with resistive PNFP may improve CP and MS in most of the planes assessed in this study while these improvements are similar when compared to PNFS. To the best of our knowledge, this is the first study comparing the effectiveness of PNFS and PNF strengthening on the cervical region.

Proprioception

There are some studies in the literature done to reveal the effectiveness of PNFS on proprioception. In a study done by Younis et al. on the lower extremity, the PNFS hold-relax technique was performed on hip flexors and it did not influence the knee proprioception (13). Another study revealed that the PNFS CRAC technique performed on the hamstring muscle did not change the knee proprioception in both short and long terms (12). The current study supports the literature on this aspect by not showing a significant influence of PNFS on most of the directions for proprioception. Proprioception is regulated by the reflexive activity of muscle spindles, Golgi Tendon Organs and joint receptors (24). After stretching, nerves are expected to become less excitable and it causes a reflex inhibition (25). However, PNFS includes the isometric and concentric contraction of the target muscle in addition to static stretching. This may prevent negative changes in proprioception following PNFS, contrary to other stretching types.

On the other hand, the literature supports that both resistive training (26) and passive ROM exercises (27) may improve joint proprioception. In

the current study, both the PNFP and CG showed significant improvement in proprioception in most directions after the intervention in accordance with the literature. The possible cause might be related to the warming-up effect of motion. Warming-up may increase the sensitivity of the proprioceptors and may help to detect the changes in the position (28). Moreover, passive motion may stimulate brain activity and help to increase the processing of proprioception (27).

In the comparison of the groups in the current study, there was a difference only in cervical flexion proprioception sense in favor of CG. A previous study revealed that the cervical flexors have a smaller activity than the cervical extensors in a neutral position among healthy subjects (29). This might be the reason why the difference between the groups can be seen only in the cervical flexion proprioception in the current study. If the flexor muscles' activity was lower than the other muscles in our participants, passive motion might cause a larger warming-up effect in these muscles and it might cause a greater increase in the sensitivity of the muscular proprioceptors. However, future studies comparing the activity level of all cervical muscles before and after such interventions will be required for detailed interpretation.

Range of Motion

Previous studies supported that PNFS has evidence to increase the ROM (30). However, in the current study, the PNFS group could not be improved significantly in terms of ROM. It was known that ROM improvements may not have lasted 6 minutes after PNFS (31). In this study, the duration till the second assessment was not noted and it could be a possible cause of not observing the improvements statistically in ROM.

A recent meta-analysis showed that resistance training done with external load might improve the range of motion. Even the exact reason is not understood well, it might be because of the stress on musculotendinous and connective tissue, and the changes in fascicle length (32). Similarly, our study revealed that there was a significant improvement in extension and right rotation ROM. Improvement seen in rotation might be because the rotational components of the PNF patterns are the key to maximum muscular activity (33). Additionally, just mentioned in the proprioception title, if the cervical extensors have a wider activity in our population, it might be the reason for the significant improvement seen in cervical extension ROM.

Within-group analysis showed that the CG has improved in more directions when compared to other groups. (14). Also, as stated before, passive motion has a warm-up effect on the muscles (27,28) This may help the musculoskeletal system to perform in wider ranges.

Muscle Strength

Literature supports that PNFS might cause a reduction in MS (30,34). After stretching, muscle's cross-bridge forming capacity could be reduced and it could take time to recover (35). Another possible cause might be that PNF may cause fatigue (14). The current study revealed that PNFS did not change MS significantly. The reason might be the duration between repetitions was long to prevent any kind of muscle fatigue. However, future studies comparing different resting durations between each PNFS application should be done to determine the effectiveness of resting duration on MS.

Most of the studies support at least a 6-week strengthening program for any gain in MS (36). However, a previous EMG study showed high muscle activations in almost all tested upper extremity muscles with PNFP, which indicates a higher ability to gain strength (15). Even if one session is not enough to improve strength, the PNFP group showed an acute improvement in rotational MS. The authors believed that this might be the potential effect of the PNF patterns which emphasize the rotational components (8). Improvements in MS of CG were not statistically significant as expected. This is because the CG underwent only PROM without causing any stretching, fatigue or active muscle contraction.

The current study has some limitations: (1) chronic adaptations or follow-up changes were not compared, (2) the effectiveness of PNFS and PNFP is analyzed only in healthy populations, not in case of pain and (3) the effectiveness of the techniques was not compared in different age groups. Future studies may focus on different populations, PNF

techniques and protocols in terms of duration, number of repetitions to draw more conclusive results.

In conclusion, the current study showed that PNFP is promising to improve CP, ROM and MS at the same time. There is a lack of studies in the literature regarding the use of different PNF techniques applied to the cervical region on CP and the data in this study suggest the need for further investigation for the use of PNF on the cervical region and also the neurophysiological mechanisms behind the use of PNF techniques.

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Author contribution: MA: Concept, Design, Supervision, Resources and Financial Support, Data Collection and Processing, Analysis and Interpretation, Literature Search, Writing Manuscript, Critical Review ÇG: Design, Supervision, Resources and Financial Support, Materials, Data Collection and Processing, Analysis and Interpretation, Literature Search, Writing Manuscript, Critical Review FŞBH: Concept, Design, Supervision, Analysis and Interpretation, Writing Manuscript, Critical Review

Explanations: This study has been never presented or published on a scientific platform.

Ethical Approval: The study protocol was accepted by Medical Ethics Committee of Medical, Surgical and Drug Researches of Yeditepe University Medical Faculty (Decision no: 1028).

Informed Consent: A written informed consent form was obtained from all owners.

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EVALUATION OF DYNAMIC BALANCE, FUNCTIONALITY AND ANTHROPOMETRIC CHARACTERISTICS IN ALPINE AND NORDIC SKIERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The dynamic balance ability, functionality level, and anthropometric structure of elite athletes are closely related to their performance during sports activities. Therefore, this study was designed to evaluate the dynamic balance, functional performance, and anthropometric characteristics of Alpine and Nordic skiers, which are different ski disciplines, and to investigate the relationships between these parameters.

Methods: The study was carried out on licensed Nordic skiers (n=29) and Alpine skiers (n=33). Dynamic balance was evaluated with the Y Balance Test, and functionality was evaluated with the Single Leg Hop for Distance Test. Sitting height and anthropometric measurements of the lower extremities were taken and recorded.

Results: The Y Balance Test result for Nordic skiers were higher (p=0.007). The results of the Single Leg Hop for Distance Test were similar in both groups (p=0.534). Lower limb length (p=0.044), thigh length (p=0.005), and leg length (p=0.005) were longer in Nordic skiers. A positive moderate correlation was found between the Y Balance Test and Single Leg Hop for Distance Test in both groups (Alpine skiing r=0.583; p <0.001; Nordic skiing r=0.457; p=0.013). A positive moderate correlation was found between sitting height and dynamic balance (r=0.432; p=0.012) and between leg length and the Single Leg Hop for Distance Test (r=0.442; p=0.010) only in Alpine skiers.

Conclusion: In conclusion, this study revealed certain differences regarding the dynamic balance, functional performance, and anthropometric characteristics of Alpine and Nordic skiers and presented guiding results in organizing of training programs for ski disciplines and in the prevention of injuries in ski athletes.

Keywords: Anthropometric Measurements, Balance, Functionality, Skiing

ALP VE KUZEY DİSİPLİNİ KAYAK SPORCULARINDA DİNAMİK DENGE, FONKSİYONELLİK VE ANTROPOMETRİK ÖZELLİKLERİN DEĞERLENDİRİLMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Elit sporcuların dinamik denge yeteneği, işlevsellik düzeyi ve antropometrik yapısı, spor aktiviteleri sırasındaki performanslarıyla yakından ilişkilidir. Bu sebeple, bu çalışma, farklı kayak disiplinleri olan Alp ve Kuzey disiplini kayak sporcularının dinamik denge, fonksiyonel performans ve antropometrik özelliklerini değerlendirmek ve bu parametreler arasındaki ilişkileri araştırmak üzere tasarlanmıştır.

Yöntem: Çalışma lisanslı Kuzey disiplini kayak sporcuları (n=29) ve Alp disiplini kayak sporcuları (n=33) üzerinde gerçekleştirildi. Dinamik denge Y Denge Testi ile, fonksiyonellik ise Tek Bacak Sıçrama Testi ile değerlendirildi. Oturma yüksekliği ve alt ekstremiteye ilişkin antropometrik ölçümler alınarak kaydedildi.

Sonuçlar: Kuzey disiplini kayak sporcularında Y Denge Testi sonucu daha yüksek bulundu (p=0,007). Tek Bacak Sıçrama Testi sonuçları her iki kayak disiplini grubunda benzerdi (p=0,534). Kuzey disiplini kayak sporcularının alt ekstremite uzunluğu (p=0,044), uyluk uzunluğu (p=0,005) ve bacak uzunluğu (p=0,005) Alp disiplini kayak sporcularına göre daha uzundu. Her iki grupta da Y Denge Testi ile Tek Bacak Sıçrama Testi arasında pozitif, orta düzeyde korelasyon bulundu (Alp disiplini r=0,583; p<0,001; Kuzey disiplini r=0,457; p=0,013). Sadece Alp disiplini kayak sporcularında oturma yüksekliği ile dinamik denge arasında (r=0,432; p=0,012) ve bacak uzunluğu ile Tek Bacak Sıçrama Testi arasında (r=0,442; p=0,010) pozitif orta düzeyde korelasyon bulundu.

Tartışma: Sonuç olarak, bu çalışma Alp disiplini ve Kuzey disiplini kayak sporcularının dinamik denge, fonksiyonel performans ve antropometrik özelliklerine ilişkin belirli farklılıkları ortaya koymuş, kayak disiplinlerine yönelik antrenman programlarının düzenlenmesinde ve kayak sporcularında yaralanmaların önlenmesinde yol gösterici sonuçlar sunmuştur.

Anahtar Kelimeler: Antropometrik Ölçümler, Denge, Fonksiyonellik, Kayak

INTRODUCTION

Skiing, which is performed on a narrow support surface and is very dynamic in nature, is a sport that is mainly divided into Alpine and Nordic disciplines, where balance, flexibility, strength, and anaerobic-aerobic capacity are at the forefront (1,2). Alpine discipline is a high-intensity exercise involving repetitive eccentric and isometric contractions in which the heel and toe are fixed to the ski with a piece called a binding, where gravity acts as a driving force. Nordic discipline, on the other hand, is an aerobic exercise in which only the toe of the foot is fixed to the ski, foot stabilization is less, there is high-intensity muscle activation in the body, and endurance and technical skills are at the forefront (3,4).

Optimal performance during sports activities is closely related to technical and tactical conditions as well as physical and mental sufficiency of the athletes. Considering that most of the sports activities are dynamic and functional, the best performance of an athlete requires several branch-specific parameters (5,6).

Balance, one of these parameters, is an important component for athletes to control their motor activities in many sports branches (7). Therefore, ski athletes should maintain their static body posture during skiing. This results in increased vestibular, visual and somatic inputs during skiing where both environment and ground changes rapidly. During skiing, angular and linear velocity changes increase the role of the vestibular system in the control of body posture, and the visual system provides information about the speed, location and direction changes of the body due to the continuous changes in the recorded image. At the same time, rough terrain, ground characteristics and changes in the body position cause permanent displacement in the athlete's center of gravity. This increases the role of the muscle, joint and skin receptors for maintaining dynamic balance (8).

The safe performance of skiing, which is technically, tactically and physically challenging and complex, requires various components of physical performance (9,10). Strength, range of motion and neuromuscular status of the lower extremities are very important for an individual to fulfill sports-related functional tasks (6). In addition to balance and functional fitness, it is stated that the morphological characteristics and body structure of the athlete are determining factors for performance in many sports branches. For this reason, anthropometric characteristics are very important in terms of predicting the physiological and physical performance of an athlete in the relevant sport branch (11,12).

Therefore, in this study, we aimed to determine the differences between Alpine and Nordic skiers in terms of dynamic balance, functional performance, and anthropometric characteristics. In addition, since we think that the sports performance integrity of the individual in skiing may be related to the ability to provide neuromuscular control and physical structure, investigating the relationships between these parameters constitutes another aim of the study. In this direction, the primary hypothesis of the study was that there was a difference between Alpine and Nordic ski athletes in terms of dynamic balance, functionality, and anthropometric characteristics, and the secondary hypothesis was that there was a relationship between intragroup dynamic balance, functionality, and anthropometric characteristics of Alpine and Nordic ski athletes.

METHODS

This cross-sectional study was conducted between August 2020 and February 2021 in the cities determined by the Turkish Ski Federation. Licensed ski athletes (n=62) between the ages of 16-29 years, registered to the Turkish Ski Federation and participated in the training and preparation camps in the 2020-2021 season activity program in the Alpine Skiing and Nordic Skiing (Ski Running) branches, were included in the study. The preliminary report which clearly stated the aims and methods of our study was submitted to the Turkish Ski Federation and the necessary permissions were obtained. The athletes included in the study were divided into two groups as Nordic ski athletes (n=29; 4 women, 25 men) and Alpine ski athletes (n=33; 7 women, 26 men) in order to evaluate and compare balance, functionality and certain anthropometric characteristics. The athletes with congenital anomalies,rheumatic diseases, history of musculoskeletal

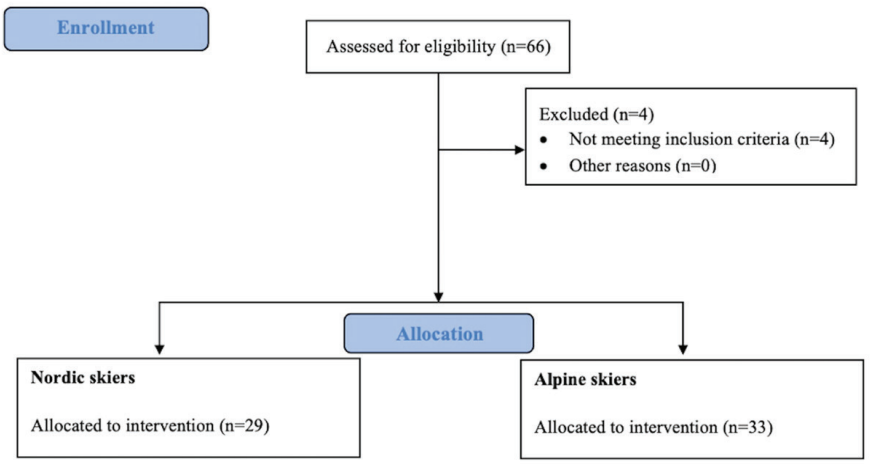

Figure 1. Flow Diagram for Participant Selection

system surgery, and any trauma (deformity,fracture, sprains, and strains) in the last 6 months were not included in the study. Participation in the research was provided on a voluntary basis and voluntary written consent was obtained from the athletes themselves or their legal guardians (Figure 1).

The measurements were made by the same investigator at the same time of day, using the same measuring instruments and techniques. The ethical approval for the study was obtained from Baskent University Medical and Health Sciences Research and Ethics Committees (Date: May 13, 2020, Project No. KA20/167).

The demographic data including age, gender, body weight, height and body mass index (BMI = body weight (kg) / height (m^2) of the participants were recorded in a form prepared by the researcher and balance and functionality evaluations were made based on the determined measurement principles, and anthropometric measurements were taken.

Assessment of dynamic balance

The dynamic balance of lower extremity was evaluated with the Y Balance Test. The test setup was created by sticking a tape in the anterior, posteromedial and posterolateral directions on a flat surface. The 135-degree angle between the anterior and posteromedial, and anterior and posterolateral directions, and the 90-degree angle between the posteromedial and posterolateral directions were determined by measuring with a goniometer. The test center was marked at the intersection of three directions (Figure 2).

Before starting the test, the participant was informed about the content of the test and watched a video on the application of the test. The participants placed their hands with their thumbs and index fingers on their iliac crests and got the starting position on one foot at the test center point. While maintaining the balance, they were asked to reach the maximum distance in the anterior, posteromedial and posterolateral directions with their other leg. The test was applied at right anterior, left anterior, right posteromedial, left posteromedial, right posterolateral, and left posterolateral directions. In order to minimize the differences in foot length, it was requested that the distal big toe be positioned in the test center in the anterior directions, and the most posterior point of the heel to be positioned in the test center in the posteromedial and posterolateral directions. All measurements were performed with bare feet to ensure standardization (Figure 2). To eliminate the learning effect, the participants were allowed to make four trials in each direction before taking test measurements to take 5-minute break between the trials and actual measurements to rest. Test measurements were taken by repeating three times for each direction. The maximum distance that the individual could reach was marked by the researcher, measured with a non-stretchable tape measure, and recorded in the measurement form in cm. During the test, the test was terminated and repeated in cases where the reaching leg could not be returned to the

starting position, the unilateral stance could not be maintained, the stance leg was displaced and the reaching leg contacted the ground. The mean of three measurements was used for each direction while evaluating the Y Balance Test results. The mean scores (cm) were calculated for the anterior, posteromedial and posterolateral directions by making necessary calculations in two ski discipline groups, and the normalized reach distance (%) was obtained by dividing these scores by the mean lower limb length and multiplying by 100. The normalized composite reach distance was also calculated (13,14) .

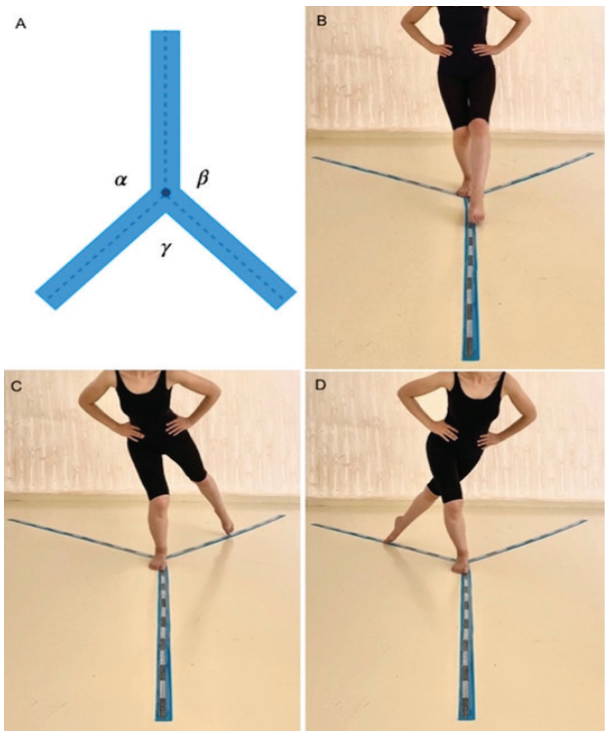

Figure 2. (A) Schematic representation of Y Balance Test (α:135°, β=135°, γ =90°), Application of Y Balance Test (B) right anterior; (C) right posteromedial; (D) right posterolateral.

Normalized reach distance (%):
(Anterior reach distance / Lower limb length) x100
(Posteromedial reach distance / Lower limb length) x100
(Posterolateral reach distance / Lower limb length) x100
Normalized composite reach distance (%):

[(Anterior+ Posteromedial+ Posterolateral) / (Lower limb length x 3)] x100.

Assessment of functionality

The lower extremity functional performances of the participants were evaluated with the Single Leg Hop for Distance Test (15). The test was performed on the participants' dominant extremities. Dominant lower extremities of the participants were determined by the Waterloo Foot Preference Questionnaire- Revised (16). The test setup was prepared by determining the starting line on a flat surface and sticking a tape extending in the horizontal direction perpendicular to this line.

Before starting the test, the content and application of the test were explained to the participant. The participant was asked to take the test with starting position on one foot with the thumbs and index fingers on the iliac crests, the dominant foot on the ground and the distal end of the foot on the starting line. Then, he/she was asked to jump to the maximum distance he/she could jump in the direction of the horizontal line and to maintain this position for a minimum of two seconds after landing. They were allowed to participate in the test with bare feet for standardization of the measurements. The individuals were given the right to try the test once before taking the test measurements. The test was performed by jumping as far as possible on their dominant feet, with three repetitions and a 30-second rest interval between repetitions to avoid fatigue (Figure 3). The heel's back edge's point of contact was marked by the researcher when the participant jumps and lands on the ground, and as a result of the participant's three successful jumps, the distance between the starting line (distal tip of the foot) and the jump point (back edge of the heel) marked during the test was measured with a non-flexible tape measure and recorded in the measurement form in cm. The test was terminated and repeated in case of loss of balance during the test, performing an additional jump during the descent, or contact of the opposite lower extremity or upper extremity with the ground. While evaluating the Single Leg Hop for Distance Test results, the mean of three successful jump scores was used for every participant (17,18).

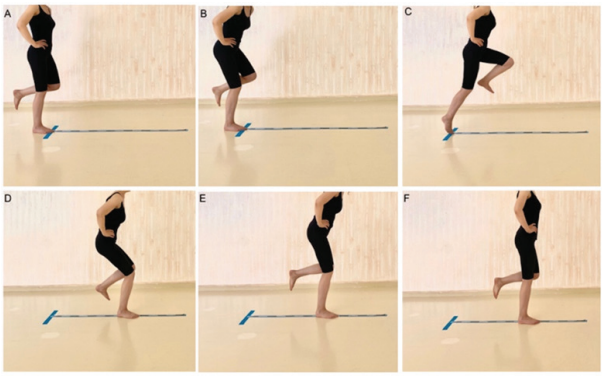

Figure 3. Single Leg Hop for Distance Test

The anthropometric measurements

Sitting height, lower limb length, thigh length, leg length, thigh circumference and leg (calf) circumference were measured as anthropometric measurements in the athletes participating in the study.

Sitting height: the distance between vertex and seating surface (19).

Lower limb length: the distance between the anterior superior iliac spine (ASIS) and the distal point of the medial malleolus.

Thigh length: The distance between the midpoint of the inguinal ligament and the proximal edge of the patella.

Leg length: The distance between the tibial plateau and the medial malleolus.

Thigh circumference: The circumference taken from the midpoint of the distance between the inguinal region and the proximal edge of the patella.

Leg circumference: circumference taken from the most bulging point of the gastrocnemius muscle (20).

Sitting height was measured using a Martin type anthropometer (GPM Model 100, Swiss), and length and circumference measurements were done bilaterally three times by the same researcher using a non-flexible tape measure. In the assessments, the mean measurement values were used without any extremity discrimination.

Sample Size

In this study, the minimum required sample size was calculated based on the primary hypothesis that there are differences between Alpine and Nordic ski athletes in terms of dynamic balance, functionality and anthropometric characteristics. Firstly, for the Two Independent Sample t test (Student's t test), which directly addresses the primary hypothesis, a total of 52 participants, 26 in each group, are required for an effect size (d) of 0.80, 80% test power, and 95% confidence level. The secondary hypothesis, which explores the relationship between dynamic balance, functionality, and anthropometric characteristics within each group of Alpine and Nordic ski athletes, was investigated using Pearson correlation analysis. For this test, a total of 58 participants are required for an effect size (ρ) of 0.50, 80% test power, and 95% confidence level. Therefore, 29 athletes from the Alpine Skiing group and 29 athletes from the Nordic Skiing group, for a total of 58 athletes, were found to be the minimal sample size needed to test all of the study's hypotheses. In the calculation of the sample size, Cohen's large effect size values were employed (21). Sample size calculations were performed using G*Power software (version 3.1, Universität Düsseldorf, 2020).

Statistical analysis

The conformity of the numerical variables to the normal distribution was analyzed with Shapiro-Wilk normality test. For numerical variables conforming to normal distribution, the descriptive statistics were presented as the mean ± standard deviation, and the median (minimum-maximum) values were given for the variables not conforming to the normal distribution. The statistical difference between the groups in terms of the distribution of numerical variables was examined with the Student's t test (Independent Sample t test) when the assumptions of normal distribution were met, and with the Mann-Whitney U test when the assumptions were not met. Correlation analysis was performed to examine the relationships among the measurement variables. Pearson Correlation Coefficient was presented when parametric test assumptions are met, and Spearman Correlation Coefficient was presented when not. When evaluating the correlation results, the absolute value of the correlation coefficient (r) was defined as low correlation or no correlation if r<0.20, weak correlation if 0.20-0.39, moderate correlation if 0.40-0.69, high correlation

Table 1. The Demographic Characteristics of Alpine and Nordic Skiers

	Alpine Ski Athletes (n=33)		Nordic Ski Athletes (n=29)		p
	Mean ± SD	Med (min-max)	Mean ± SD	Med (min-max)	
Age (years)	19.18±2.47	19 (16-25)	20.90±3.41	20 (16-29)	0.050[b]
Body Weight (kg)	67.36±11.10	68 (46-84)	68.22±12.03	70 (41-92)	0.771[a]
Height (cm)	172.94±6.58	174 (158-183)	176.28±7.49	178 (155-187)	0.067[a]
BMI (kg/m²)	22.48±3.24	21.98 (15.70-29.36)	21.83±2.87	21.98 (17.07-28.40)	0.412[a]

Data are presented as mean ± SD and median (min-max), * p< 0.05, a: Student t test, b: Mann-Whitney U test, BMI: Body mass index, cm: centimeter, kg: kilogram, m²: meter square, Med: Median, min: minimum, max: maximum, SD: Standard deviation.

Table 2. Comparison of Dynamic Balance and Functionality Measurements Between Groups

	Alpine Ski Athletes Mean ± SD Med (min-max)	Nordic Ski Athletes Mean ± SD Med (min-max)	p
YBT Anterior (%)	84.72 (63.35-136.56)	96.51 (69.75-131.97)	0.072[b]
YBT Posteromedial (%)	93.23±15.14	104.44±14.00	0.004[a*]
YBT Posterolateral (%)	84.52 (55.09-110.93)	93.03 (57.32-128.43)	0.036[b*]
YBT Composite (%)	89.17±14.33	99.03±13.41	0.007[a*]
Single Leg Hop for Distance Test (cm)	110.59±33.98	115.22±23.91	0.534[a]

Data are presented as mean ± SD and median (min-max), * p< 0.05, a: Student t test, b: Mann-Whitney U test, cm: centimeter, Med: Median, min: minimum, max: maximum, SD: Standard deviation, YBT: Y Balance Test.

if 0.70-0.89, and very strong correlation if 0.90-1.00 (22).

Intraclass correlation coefficient (ICC) was calculated to evaluate the measurement reliability of the researcher who made the measurements, and the participant's reliability regarding balance and functionality tests. The ICC model was chosen as the average measures two-way mixed model, and absolute agreement values were obtained. Type 1 error probability was determined as α=0.05 in all hypothesis tests, and SPSS v25.0 package program (Statistical Package for the Social Sciences package program version 25.0, SPSS Inc., Chicago, IL, USA, 2017) was used for the statistical analyses.

RESULTS

Licensed Alpine Skiers (n=33, 7 women, 26 men) and Nordic skiers (n=29; 4 women, 25 men) aged between 16 and 29 years, registered to the Turkish Ski Federation and included in the 2020-2021 season activity program, were included in our study. The demographic characteristics of the partici-

Table 3. Comparison of Anthropometric Measurements Between Groups

Anthropometric measurements (cm)	Alpine Ski Athletes Mean ± SD Med (min-max)	Nordic Ski Athletes Mean ± SD Med (min-max)	p
Sitting height	87.80±3.92	89.68±3.80	0.061[a]
Lower limb length	90.86±3.60	93.33±5.48	0.044[a*]
Thigh length	38.29±1.52	39.72±2.26	0.005[a*]
Leg length	36.92 (32.75-39.53)	38.25 (32.33-41.00)	0.005[b*]
Thigh circumference	49.75±5.61	48.37±4.61	0.298[a]
Leg circumference	34.53 (30.00-42.50)	34.50 (27.50-39.50)	0.494[b]

Data are presented as mean ± SD and median (min-max), * p< 0.05, a: Student t test, b: Mann-Whitney U test, cm: centimeter, Med: Median, min: minimum, max: maximum, SD: Standard deviation.

Table 4. The Relationship of Intragroup Dynamic Balances of Disciplines with Functionality and Anthropometric Measurements

	Y Balance Test Composite (%)			
	Alpine Ski Athletes (n=33)		Nordic Ski Athletes (n=29)	
	Correlation coefficient	p	Correlation coefficient	p
Single leg hop for distance test (cm)	0.583	0.001[a*]	0.457	0.013[a*]
Sitting height (cm)	0.432	0.012[a*]	0.063	0.746[a]
Lower limb length (cm)	0.318	0.072[a]	0.004	0.983[a]
Thigh length (cm)	0.294	0.096[a]	-0.047	0.808[a]
Leg length (cm)	0.286	0.107[a]	-0.021	0.913[b]
Thigh circumference (cm)	-0.233	0.192[a]	0.120	0.535[a]
Leg circumference (cm)	-0.107	0.554[b]	0.120	0.535[a]

Data are presented as correlation coefficient, * p<0.05, a: Pearson correlation coefficient, b: Spearman rho correlation coefficient, cm: centimeter.

pants are presented in Table 1, and there were no statistically significant differences between Alpine and Nordic skiers in terms of the characteristics of the participants (Table 1).

The Intraclass Correlation Coefficient (ICC) values and 95% Confidence levels we obtained as a result of the repeated measurements we performed are as follows: 0.994-1.000 for anthropometric measurements, 0.912-0.967 for Y Balance Test value and 0.953 for Single Leg Hop for Distance Test. These ICC values indicate that our measurements have a high level of repeatability (22).

The dynamic balance values of Alpine and Nordic skiers regarding the three dimensions of the Y Balance Test, the composite balance value and the measurement results of the Single Leg Hop for Distance Test are presented in Table 2. When the dynamic balances of Alpine and Nordic skiers were compared regardless of extremity, there was no significant difference in the anterior direction (p=0.072), however the balance values in the posteromedial (p=0.004) and posterolateral (p=0.036) directions were higher in Nordic skiers. When the dynamic balances of Alpine and Nordic skiers were compared in terms of composite balance value without any extremity and direction discrimination, the composite balance value of Nordic skiers was higher than Alpine skiers (p=0.007) (Table 2).

No statistically significant differences were found between Alpine and Nordic skiers in terms of the functionality measurements evaluated with the Single Leg Hop for Distance Test (p=0.534) (Table 2).

Anthropometric measurements of Alpine and Nordic skiers were similar in terms of sitting height, thigh circumference or leg circumference (p>0.05).

Table 5. The Relationship Between Disciplines' In-Group Anthropometric Measurements and Functionality

	Single Leg Hop for Distance Test (cm)			
	Alpine Ski Athletes (n=33)		Nordic Ski Athletes (n=29)	
Anthropometric measurements (cm)	Correlation coefficient	p	Correlation coefficient	p
Sitting height	-0.030	0.870[a]	0.301	0.112[a]
Lower limb length	0.288	0.105[a]	0.260	0.173[a]
Thigh length	0.262	0.141[a]	0.179	0.354[a]
Leg length	0.442	0.010[a*]	0.211	0.272[b]
Thigh circumference	0.146	0.416[a]	0.250	0.190[a]
Leg circumference	0.206	0.251[b]	0.175	0.365[a]

Data are presented as correlation coefficient, * p<0.05, a: Pearson correlation coefficient, b: Spearman rho correlation coefficient, cm: centimeter.

Lower limb length (p=0.044), thigh length (p=0.005) and leg length (p=0.005) were significantly longer in Nordic skiers compared to Alpine skiers (Table 3).

The relationships of Y Balance Test composite balance values with Single Leg Hop for Distance Test and anthropometric measurements are presented in Table 4 for Alpine and Nordic skiers. A positive moderate relationship was found between Y Balance Test and Single Leg Hop for Distance Test in both ski discipline groups (Alpine skiing r= 0.583; p <0.001; Nordic skiing r= 0.457; p=0.013). When the relationship between Y Balance Test and anthropometric measurements was examined, a positive moderate correlation was found between sitting height and composite balance value only in Alpine skiers (r=0.432; p=0.012) (Table 4).

When the relationship between the anthropometric measurements of Alpine and Nordic skiers and the Single Leg Hop for Distance Test was examined, a moderate positive correlation was found only between the leg length of Alpine skiers and the Single Leg Hop for Distance Test (r=0.442; p=0.010) (Table 5).

DISCUSSION

The main findings of our study, in which we compared Alpine and Nordic ski athletes, were that dynamic balance was better in Nordic ski athletes than Alpine ski athletes and that lower limb, thigh, and leg lengths were longer in Nordic ski athletes.

The success in a high-level competition depends on performance judged in fractions of a second for professional skiers. Therefore, it is very important to know the factors that may affect or limit the ski performances of the athletes (23). In addition to internal factors such as the athlete's anthropometric characteristics, ski racing technique or biological maturity, the ability to provide neuromuscular control and functional fitness are effective on the performance success and injury risk (10).

In this context, the results of our study on Alpine and Nordic skiers were compared with similar studies in the literature, since there are very few studies on the evaluation and comparison of dynamic balance, functionality and anthropometric characteristics in skiers. Noe and Paillard investigated the relationship between postural control and the level of expertise in regional and national Alpine ski athletes, and reported the detrimental effect of the athletes' rigid ski boots the on postural control in the long term due to the mechanical restriction of ankle movements. The authors stated that this affects the postural control of the athletes negatively in cases of static and mediolateral instability, however postural control is not affected in case of anteroposterior instability since the boots allow some ankle movement in the sagittal plane (24).

This result made us think that the dynamic balance is better in Nordic skiers, as the ski boots used in the Nordic discipline allow ankle movement more, unlike the ski boots used in the Alpine discipline. Cote et al. studied on healthy volunteers and investigated the effects of pronated and supinated foot postures, as determined by navicular-drop measures, on static and dynamic postural stability. The authors stated that the individuals with the supinated foot posture had a greater limit of stability in the lateral direction due to the pressure they applied to the lateral edge of the foot, while the individuals with the pronated foot posture had a decreased ability to provide a stable support due to the tendency to collapse towards the medial edge of the foot, and their foot mobility increased (6). Considering that the weight-bearing foot takes a sustained pronation position during the turns in Alpine skiing races held at high speed, we think that the pronator foot muscles of Alpine ski athletes may be stronger than the supinator foot muscles, and this may straighten the medial longitudinal arch. For this reason, as Cote et al. stated in their study, we think that the increased foot mobility with the flattening of the medial longitudinal arch affects the dynamic balance negatively in Alpine ski athletes. In their study on individuals with chronic ankle instability, Hubbard et al. found a positive correlation between the posteromedial and posterolateral reach of the Star Excursion Balance Test and the abduction and extension strength of the hip (25). Differently, in our study, in which we included healthy ski athletes, when Nordic ski running races are examined in terms of movement patterns, the athlete's successive hip extension and abduction movements during running and repetitive contractions will increase extensor and abductor muscle strength. This explains our finding con-

cerning longer posteromedial and posterolateral reach distance in the Nordic skiers when compared to the Alpine skiers.

In our study, we compared the functional performance of the lower extremity with the Single Leg Hop for Distance Test in Alpine and Nordic skiers and did not find any significant difference between the groups in terms of functional performance parameter. We think that the fact that both groups of athletes use their lower extremities very actively and functionally during both races and training supports this situation.

Alpine and Nordic ski athletes, whom we compared in terms of anthropometric characteristics, were compared similarly by Alaeddinoğlu on 13 Alpine and 15 Nordic skiers. Our study is parallel to Alaeddinoğlu's study in terms of measurement groups and parameters, and our results are similar to Alaeddinoğlu's results: the sitting height was higher in Nordic skiers compared to Alpine skiers, and thigh and leg circumferences were greater in Alpine skiers compared to Nordic skiers, however, the differences were not statistically significant. Contrary to Alaeddinoğlu's results, we found significantly longer thigh length and leg length in Nordic skiers compared to Alpine skiers (26).

Haksever et al., on the other hand, investigated the effect of standard balance training on balance and functionality in healthy individuals, and reported a significant positive improvement in dynamic balance and functionality at the end of the training (15). This situation made us think that the dynamic balance that develops with balance training also affects the functionality of the individuals positively, and concerning our study, it supports the significant correlation between dynamic balance and functionality in both ski discipline groups.

Lesnik et al. tested national Alpine skiers over two competitive seasons, U14 (12-13 years) and subsequently U16 (14-15 years), concluded that the balances of participants were maintained regardless of the significant changes in their anthropometric statuses including body mass and body length and stated this finding supported the studies that found skiing as an effective balance exercise (27). In our study, there was no significant correlation between the anthropometric measurement values of the lower extremities of Alpine and Nordic skiers and their dynamic balance, and as Lesnik et al. stated in their study, we think that this is due to continuous protection and improvement of the balance of the athletes in skiing, independent of their anthropometric characteristics.

Yıldırım and Özdemir investigated the relationship between the anthropometric characteristics of 56 male handball players and their jump distances, and reported that the horizontal jump distance increased as the leg length increased. This was explained by the contribution of leg length to anaerobic power as well as its effect on explosive strength. When the relationship between leg length and Single Leg Hop for Distance Test was examined in our study, a significant correlation was found in the Alpine skiing group, similar to the study of Yıldırım and Özdemir (28). On the other hand, Temur reported that the thigh and leg circumferences did not have a significant relationship with the vertical and horizontal jump distance in 54 university students actively doing sports in different branches. In our study, the absence of a significant correlation between the circumference measurements of Alpine and Nordic skiers and the Single Leg Hop for Distance Test was similar to Temur's results (29).

In conclusion, this study revealed certain differences regarding the dynamic balance, functional performance and anthropometric characteristics in Alpine and Nordic skiers, and presented guiding results in order to observe the relationships among these values. The findings of our study show that dynamic balance is better in Nordic ski athletes than in Alpine ski athletes. Length measurements of the lower extremities were also found to be longer in Nordic ski athletes. Additionally, our study revealed a positive relationship between balance and functionality in ski athletes. We think that our results constitute a reference for the selection of athletes' exercises suitable for their skiing discipline, and in this context, the training programs planned to improve balance and functional performance will contribute positively to the performance success of the athletes and will be effective in preventing activity-related injuries. However, we believe that the anthropometric measurement results obtained from Alpine and Nordic ski athletes are instructive in directing individuals to sports branches suitable

for their physical structures at an early age.

This study has a number of limitations. Conducting the study during the pandemic condition made it difficult to reach the desired number of athletes in the research population. For this reason, the limitations of the study are that the age distribution could not be performed in a certain group (31 adults or 31 adolescents) and the measurements of a small percentage (12.9%) of the population participating in the study were taken during the camp. Moreover, although the distribution of men and women in the participant groups is not homogeneous, the same applies to both groups. Another limitation of this study is that the distribution of men and women is not homogeneous due to the low number of female athletes in this sport.

At the same time, we think that the data obtained from our study will be useful for physiotherapy and rehabilitation, medicine, and sports sciences, and we suggest that the anthropometric differences of the athletes related to heredity and the training age of the athletes should be taken into consideration in future similar studies.

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IMMEDIATE EFFECT OF MANUAL THERAPY ON RESPIRATORY FUNCTIONS AND RESPIRATORY MUSCLE STRENGTH IN STROKE PATIENTS

ORIGINAL ARTICLE

ABSTRACT

Purpose: Although the benefits of manual therapy (MT) are known, studies on its effect on stroke patients are limited. The aim of this study was to evaluate the immediate effects of MT on respiratory function and respiratory muscle strength in stroke patients.

Methods: A total of forty-seven patients, comprising 33 men and 14 women, were enrolled in the study and then randomly assigned to either the MT group (n=31) or the control group (n=16). All participants meet with initial pulmonary function and respiratory muscle testing and then rested supine for 10 minutes before the procedure. The respiratory tests were repeated immediately after the procedure. Tests included: maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC, and peak expiratory flow (PEF).

Results: In intra-group comparisons, a significant improvement was observed in all measured parameters in the MT group ($p<0.05$), while no significant change was observed in the control group except FEV1 and FEV1/FVC values ($p>0.05$). In comparisons between groups, a statistically significant difference was found in FEV1, FEV1/FVC, PEF and MEP values($p<0,05$)

Conclusions: This study demonstrated that manual therapy had a immediate positive effect on lung function and respiratory muscle strength in stroke patients.

Keywords: Manual Therapy, Pulmonary Function Test, Respiratory Muscles, Stroke

İNME HASTALARINDA MANUEL TERAPİNİN SOLUNUM FONKSİYONLARI VE SOLUNUM KAS KUVVETİ ÜZERİNDEKİ ANLIK ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Manuel terapinin (MT) faydaları bilinmesine rağmen inme hastalarında etkisi ile ilgili çalışmalar sınırlıdır. Bu çalışmanın amacı, inme hastalarında MT'nin solunum fonksiyonu ve solunum kas kuvveti üzerindeki ani etkilerini araştırmaktır.

Yöntem: Çalişmaya kırk yedi hasta (33 erkek, 14 kadın) dahil edildi ve katılımcılar randomize olarak MT grubuna (n = 31) ve kontrol grubuna (n = 16) ayrıldı. Tüm katılımcıların, başlangıçta solunum fonksiyonu ve solunum kas testi değerlendirildi ve ardından girişim öncesi 10 dakika boyunca sırtüstü dinlendiler. Girişimden hemen sonra solunum testleri tekrarlandı. Testler şunları içeriyordu: maksimum inspiratuar basınç (MIP) ve maksimum ekspiratuar basınç (MEP), zorlu vital kapasite (FVC), 1. saniyedeki zorlu ekspiratuar hacim (FEV1), FEV1/FVC ve tepe ekspiratuar akış (PEF).

Sonuçlar: Grup içi karşılaştırmalarda MT grubunda ölçülen tüm parametrelerde anlamlı iyileşme gözlenirken ($p<0,05$), kontrol grubunda ise FEV1 ve FEV1/FVC değerleri dışında anlamlı değişiklik görülmedi($p>0,05$). Gruplar arası karşılaştırmalarda FEV1, FEV1/FVC, PEF ve MEP değerlerinde istatistiksel olarak anlamlı fark bulundu($p<0,05$).

Tartışma: Bu çalışma, manuel tedavinin inmeli hastalarda solunum fonksiyonu ve solunum kas kuvveti üzerinde anlık olumlu etkisi olduğunu göstermektedir.

Anahtar Kelimeler: Manuel Terapi, Solunum Fonksiyon Testi, Solunum Kasları, İnme

INTRODUCTION

A stroke refers to a persistent neurological impairment that endures beyond 24 hours and stems from either an infarction or hemorrhage affecting a substantial area of the brain (1). The neurological impairment doesn't just impact motor or sensory functions; it also extends to the respiratory system. This leads to alterations in breathing patterns, decreased respiratory volume and airflow, and weakness in the respiratory muscles (2).

In hemiplegia, which is one of the classic symptoms of stroke, patients' pulmonary functions decrease due to the decreased expansion of the chest on the hemiplegic side and the insufficiency of the respiratory muscles. In addition, the ankylosis and limited use of muscles cause oxygen deficiency, and the increased oxygen demand is not met (3). In addition, paralysis of the diaphragm and respiratory muscles after stroke results in decreased thoracic expansion and a restrictive breathing pattern. If this condition persists, it can lead to muscle fibrosis. As a result, chest expansion decreases during breathing (4). The limited movement in the thoracic spine shows a connection to reduced forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). When the chest wall becomes stiffer, it hampers the mechanics of ventilation. To enhance pulmonary function, it's suggested to alleviate stiffness by enhancing chest wall mobility (5).

Traditional stroke rehabilitation primarily targets the motor control deficits in patients(6). Yet, it's crucial to acknowledge that neurological issues often underlie various respiratory problems, and respiratory failure might arise as a consequence of neurological conditions or symptoms (7). Hence, apart from standard treatments, specific approaches are necessary to enhance respiratory function and bolster respiratory muscle strength in stroke patients (8).

Manual therapy (MT) encompass evidence-supported hand movements and maneuvers utilized to alleviate pain, enhance tissue flexibility, widen range of motion, and induce relaxation, commonly applied in clinical settings (9). These techniques are believed to positively impact chest wall mobility and respiratory functions by expanding joint motion (10). While most studies investigating chest manipulation techniques focused on individuals with respiratory conditions (11), Noll et al. observed that a single session of osteopathic manual therapy effectively enhanced both static and dynamic pulmonary function in elderly chronic obstructive pulmonary disease (COPD) patients (12). Similarly, another study involving COPD patients reported improvements in dynamic lung function parameters (13).

Although there is a preliminary study in the literature in which a single spinal manipulation was performed in hemiplegic patients (14), no study has been found in which an MT protocol including various manual therapy techniques such as myofascial release and mobilizations was applied in hemiplegic patients and its effects on respiration were investigated. Therefore, the aim of this study is to examine the immediate effects of thoracic manual therapy in hemiplegics on respiratory function.

METHODS

Study Design

A prospective, single blind randomized controlled trial was conducted, registered under clinicaltrials.gov number: NCT04503499. Ethical clearance was granted by the Research Ethics Committee for Science, Social, and Non-Interventional Health Sciences of Istanbul Okan University (Meeting date: 04.07.2018 and Decision Number: 96), aligning with the principles outlined in the Declaration of Helsinki and Good Clinical Practice Guidelines. The study spanned from September 2019 to August 2020, during which participants provided informed consent before random allocation into two groups.

Participants

Eighty patients with chronic stroke were invited from the Rehabilitation and Disability Center of Bayrampasa Municipality. Sixty eight patients who met the inclusion criteria were included in the study. The inclusion criteria were: Stroke at least 6 months ago, age between 18 and 60 years, a score of > 24 in the Mini-Mental Test, lower extremity score of 4-6 in the Brunnstrom stage, no cognitive impairment, willingness and voluntariness to work. Exclusion criteria were various vestibular and orthopedic problems, visual or hearing impairment, known cardiopulmonary disease, transient ischemic

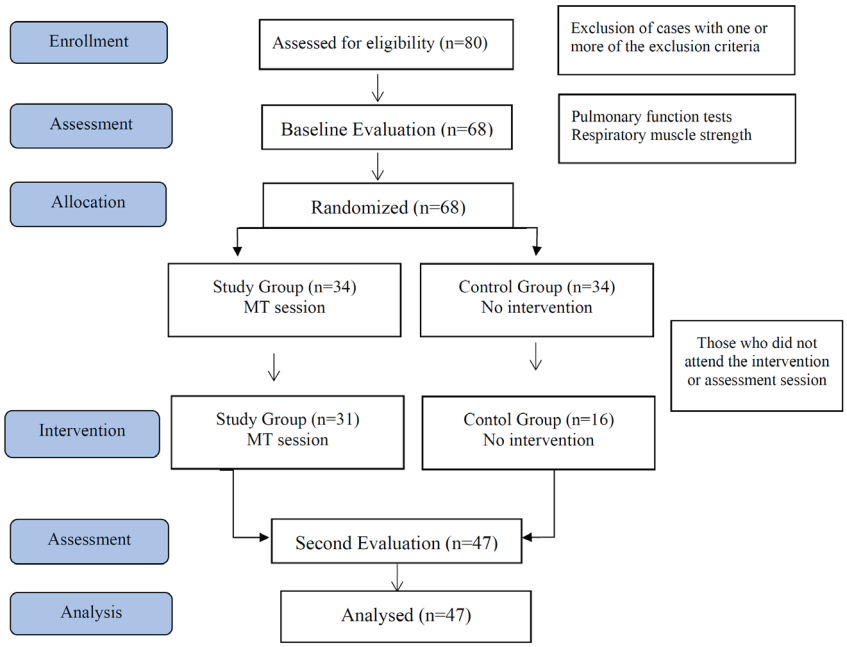

Figure 1. CONSORT Flow Diagram of Study

attack or multiple strokes, no independent balance in sitting and standing, and chronic disease.

Sixty eight participants were randomly divided via the e-picos website (1:1 allocation) into 2 groups, a MT group (n=34) and a control group (n=34). (Fig. 1). 3 participants included in the MT group and 18 participants included in the control group did not come on the day of the study. For this reason, the MT group was completed with 31 patients and the control group with 16 patients.

Outcome measures

All measurements were taken before and after a single session of the MT application. All patients were rested before the start of the study to avoid fatigue. After the MT application, a 2-minute rest was taken before the measurement was performed again. Measurements and MT application were made by two different researchers who were blind to each other.

Pulmonary Function Tests

Spirometry tests were conducted using a portable spirometry device (Spirobank MIR, Italy) in adherence to the criteria outlined by the American Thoracic Society and European Respiratory Society. All patients were seated and wore nose clips during the procedures. The test was repeated three times, a recognized and reliable method for ensuring consistent effort. Baseline measurements for forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, and peak expiratory flow (PEF) were recorded for the study (15,16).

Respiratory muscle strength

Respiratory muscle strength was assessed using a portable electronic oral pressure monitor (Micro Medical MicroMPM, UK). This device measures two key indicators, maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), which evaluate overall strength in inhaling and exhaling muscles by recording the highest mouth pressures (17). For MIP measurement, the airway is sealed after maximal exhalation, and the individual is instructed to execute and sustain a maximal inhalation. Conversely, MEP is measured with the airway sealed after maximal inhalation, prompting the subject to exhale maximally against the closed airway. To ensure accuracy, three trials were conducted, and the best result was selected. Patients were directed to take deep breaths, use a nose clip, and seal their lips firmly around the mouthpiece. Throughout the test, they were prompted to inhale maximally for MIP and exhale maximally for MEP, with a one-minute rest interval between each trial (17).

MT protocol

The MT group received a consistent 45-minute MT session conducted by the same physical therapist. The protocol encompassed various sequential techniques, including suboccipital decompression, cervical joint sliding (anterior/posterior), relaxation of sternocleidomastoid and trapezius myofascial, sternoclavicular joint sliding (anterior/posterior), intercostal and paravertebral myofascial relaxation, diaphragmatic relaxation, ribs lifting, scapulothoracic joint mobilization, and thoracic vertebral joint sliding (anterior/posterior) (12,13). Each myofascial release technique was applied for approximately 3-5 minutes. The gliding approach was repeated five times for each joint, with each repetition lasting 30 seconds (Appendix 1).

Participants in the control group were positioned in the same position as the MT group and rested for 45 minutes without any intervention.

Statistical analysis

Statistical analyses were conducted using SPSS 22.0 (SPSS Inc, USA). The Kolmogorov-Smirnov/Shapiro-Wilk test confirmed the normal distribution of continuous variables. Descriptive statistics utilized mean ± standard deviation for continuous variables and patient count with percentage (%) for categorical variables. The chi-square test compared nominal variables between the MT and control groups, while Student's T-test assessed differences between groups. Within-group comparisons were performed using paired-sample T-tests. Statistical significance was set at $P<0.05$. Repeated-measures analysis of covariance (ANCOVA), with baseline as a covariate, evaluated the interaction effect between group and time. Cohen's d test determined effect sizes between groups: ≤0.50 indicated a low effect, 0.51–0.8 a medium effect, and ≥0.81 a large effect, characterizing differences in treatments (18).

Sample size

A two-way hypothesis was established and it was found that a total of 62 cases, 31 participants in each group, should be included in order to obtain an effect size of 0.7 (medium-large effect size) with α=0.05 and 80% power. Considering drop out, 80 stroke patients were invited to the study. Of the invited participants, 68 met the inclusion criteria. 68 patients were divided into 2 groups as control (n=34) and study (n=34) and appointments were made for measurement and MT application sessions. 18 participants in the control group and 3 participants in the MT group did not show up for the measurement and MT application session on the day they were invited. Necessary measurement and MT application of the patients who attended the sessions were completed. Before the completion of the drop outs, a power check of the study was made. When the power calculation of the post-hypothesis study was made based on the MIP value, the mean difference before and after the participants in the control group was -1.31±8.83, and the mean difference before and after the participants in the MT group was 8.39±9.1, and when

Table 1. The Demographic and Clinical Features of the Participants

Characteristics	MT Group (n=31)	Control Group (n=16)	p
Age (years)	59.10±7.54a	59.87±11.07	0.777
Body Mass Index (kg/m^2)	28.67±2.87	26.52±2.63	**0.016***
Time since stroke (months)	53.00±44.69	65.62±49.59	0.381
Gender			
Male	23 (75.2%)[b]	10 (62.5%)	0.406
Female	8 (25.8%)	6 (37.5%)	
Stroke type			
Hemorrhagic	2 (6.5%)	1 (6.2%)	0.979
Ischemic	29 (93.5%)	15 (93.8%)	
Side affected			
Right	13 (42%)	12 (75%)	**0.031***
Left	18 (58%)	4 (25%)	

Chi-square test. Student T test. *. p<0.05; Data are mean ± standard deviation[a] and n (%)[b]; Statistically significant values are given in bold.

α=0.05, the power was calculated as 94.2%. For this reason, although the drop out rate was high, participant recruitment was not continued.

RESULTS

The study comprised 47 participants, with 31 in the MT group and 16 in the control group, all stroke patients. In the MT group, participants had a mean age of 59.10±7.54, while in the control group, it was 59.87±11.07. The disease duration for MT group participants was 53.00±44.69 months and 65.62±49.59 months for those in the control group. Both study and control groups exhibited similarities in age, sex, disease duration, and stroke type (p>0.05). However, differences were noted in BMI and affected side between the groups (p<0.05, Table 1). Before to the measurement and MT application, there were no significant differences in measured values between the study and control groups (p > 0.05, Table 2). In intra-group comparisons, a significant improvement was observed in all measured parameters in the MT group (p<0.05), while no significant change was observed in the control group except FEV1, FEV1% pred, FEV1/FVC

Table 2. Comparison of All Measurements Taken Before Treatment Between the Groups

Variables	MT Group (n=31) Mean ± SD	Control Group (n=16) Mean ± SD	p
FEV_1	2.08±0.64	2.12±0.88	0.632
$FEV_{1,}$ % pred	70.64±18.95	77.81±26.33	0.289
FVC	2.81±0.84	2.68±1.005	0.62
FVC, % pred	79.35±16.82	79.00±23.05	0.952
FEV_1/FVC	71.58±15.006	78.87±12.39	0.102
FEV_1/FVC, % pred	92.90±18.95	102.75±16.30	0.084
PEF	2.87±1.37	3.28±1.68	0.382
PEF, % pred	38.54±17.63	45.00±20.69	0.269
MIP, cmH_2O	61.61±23.28	60.18±38.47	0.257
MEP, cmH_2O	76.03±30.91	80.12±23.83	0.646

Abbreviations: FEV1. forced expiratory volume in 1 s; FVC. forced vital capacity; PEF. forced expiratory flow; % pred. % predicted; MIP. Maximal Inspiratory Pressure; MEP. Maximal Exspiratory Pressure; *. p<0.05; **. p<0.001. Statistically significant values are given in bold.

Table 3. Comparison of Pulmonary function and Respiratory Muscle Strenght Between the Groups

	MT Group (n=31)		Within Group p	Control Group (n=16)		Within Group p	Treatment affect p	Cohen's d
	Pre Mean ± SD	Post Mean ± SD		Pre Mean ± SD	Post Mean ± SD			
FEV_1	2.01±0.64	2.27± 0.69	**<0.001****	2.12±0.88	1.91± 0.83	**0.004****	**<0.001****	0.353
$FEV_{1,}$ % pred	70.64±18.95	79.64± 17.66	**<0.001****	77.81±26.33	70.25± 21.73	**0.003****	**<0.001****	0.371
FVC	2.81±0.84	2.96± 0.85	**0.010***	2.68±1.005	2.73± 1.14	0.491	0.379	0.017
FVC, % pred	79.35±16.82	83.38± 16.78	**0.008***	79.00±23.05	80.43± 25.59	0.535	0.317	0.022
FEV_1/FVC	71.58±15.006	76.64 ±10.16	**0.007***	78.87±12.39	71.18± 14.76	**0.014***	**<0.001****	0.269
FEV_1/FVC, % pred	92.90±18.95	99.48±12.74	**0.006***	102.75±16.30	92.68±19.06	**0.013***	**<0.001****	0.274
PEF	2.87±1.37	3.71±1.66	**0.001****	3.28±1.68	3.04±1.84	0.329	**0.004***	0.168
PEF, % pred	38.54±17.63	49.19±19.40	**0.001****	45.00±20.69	41.50±21.8	0.253	**0.002***	0.19
MIP, cmH_2O	61.61±23.28	70.00± 24.84	**<0.001****	60.18±38.47	58.87±39.03	0.534	0.716	0.003
MEP, cmH_2O	76.03±30.91	84.48±29.29	**<0.001****	80.12±23.83	79.68±27.50	0.874	**0.012***	0.132

Abbreviations: FEV1. forced expiratory volume in 1 s; FVC. forced vital capacity; PEF. peak expiratory flow; % pred. % predicted; MIP. Maximal Inspiratory Pressure; MEP. Maximal Expiratory Pressure. *. p<0.05; **. p<0.001. Statistically significant values are given in bold.

and FEV1/FVC, % pred values (p>0.05). Following the measurement and MT application, changes in FEV1, FEV1% pred, FEV1/FVC, FEV1/FVC% pred, PEF, PEF%, and MEP (cmH2O) values significantly varied between the MT and control groups (p<0.05, Table 3). Nonetheless, there were no significant differences observed in FVC, FVC% pred, and MIP (cmH2O) values between the groups (p>0.05, Table 3).

DISCUSSION

This study highlighted the immediate effects of lung function and respiratory muscle strength in chronic stroke patients following a single MT session.

A prior study investigating the immediate impact of MT on lung function in stroke patients noted increased lung function scores among those using MT, but without significant improvement. Notably, patients utilizing the MT technique showed significant differences favoring FVC and FEV1 compared to the control group (14). Yelvar et al. similarly observed immediate improvements in lung function and inspiratory muscle strength among COPD patients after a single MT session (13). However, in another study focusing on short-term effects, the application of a soft-tissue-based MT form did not lead to immediate improvements in respiratory function (19).

Noll et al. showcased the effectiveness of single-session osteopathic MT in enhancing lung function among elderly COPD patients (12). Similarly, in our study, there was a statistically significant difference in lung function parameters between baseline and post-treatment. MT techniques are known to positively impact the autonomic nervous system, with diaphragm relaxation activating the parasympathetic system and sympathetic mobilization inhibiting its activation. This regulation leads to improved lung function, increased oxygen saturation, and lowered heart and respiratory rates (20,21). As a result of our study, the reason for the significant improvement in values such as FEV1, FEV1/FVC, PEF and MEP in the study group compared to the control group is due to the relationship between this parasympathetic activity and MT. Because increased parasympathetic activity may have increased expiratory flows by reducing obstruction. A low FVC value indicates a restrictive type pattern and it is known that stroke patients have a restrictive type pattern (22,23). Since a single MT application may not have changed the breathing pattern resulting from the nature of the disease, there may have been no change in FVC and MIP values between the study and control groups as a result of the study. Our results emphasize MT's immediate impact on respiratory muscle strength in chronic stroke patients. Post-stroke complications can affect breathing by impacting the diaphragm and causing trunk postural deviations. Moreover, biomechanical changes within the respiratory system involving various muscles, chest, and abdomen may contribute to declining lung function (24).

This study's strengths lie in its randomized controlled design, ensuring similarity and homogeneity between the study and control groups. Data collectors remained blinded throughout, enhancing objectivity. Notably, our research is among the first to directly explore manual therapy's impact on pulmonary function in stroke patients. However, interpreting the results warrants consideration of limitations. Despite the significant results before and after treatment, the fact that no treatment was applied to the control group remains a limitation. Additionally, unequal participant numbers between the MT and control groups pose another limitation. Investigating only the immediate effects of MT is also a constraint; long-term effects merit further exploration. Although our sample size aligns with power analysis, larger studies may validate our findings. This study sets a groundwork for more comprehensive research endeavors.

In summary, this single-blind, randomized controlled trial demonstrated improvements in immediate increased respiratory muscle strength, and improvement in respiratory function in stroke patients undergoing MT compared with the control group. For this reason, MT can be applied together with conventional treatment to improve respiratory functions in stroke patients. The long-term effect of the application should be investigated in future studies on stroke rehabilitation.

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EVALUATION OF FAMILY IMPACT OF CHILDREN WITH CEREBRAL PALSY AND FAMILY CAREGIVER'S QUALITY OF LIFE, SLEEP QUALITY AND INDIVIDUAL PHYSICAL EDUCATION SATISFACTION: A MIXED STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: Cerebral Palsy (CP) is a disease that has significant effects on both the child and the family. The objective of this study is to examine the influence of the family, quality of life, sleep quality and individual physical education (IPE) of family caregivers of children with CP. In addition, it is planned to detail the factors affecting their satisfaction through semi-structured individual interviews.

Methods: Family caregivers of 55 children diagnosed with CP between the ages of 1 and 15 were included in the study. Demographic information with "Demographic Information Survey", the functional status of the child's with "Gross Motor Function Classification System (GMFCS)" the impact of the child on the family with "Impact on Family Scale (IoFS)", caregiver's quality of life with "World Health Organization Quality of Life Scale - Short Form (WHOQOL-BREF) ", caregiver's sleep quality was evaluated with " Pittsburgh Sleep Quality Index (PSQI)" and the satisfaction with IPE was questioned with the "Pediatric Quality of Life Healthcare Parental Satisfaction Scale (PedsQL)". Qualitative data were obtained through semi-structured individual interviews.

Results: In our study, GMFCS level was negatively correlated with WHOQOL-BREF (p=0.028) and positively correlated with PSQI (p=0.002). In addition, the IoFS scale correlated negatively (p=0.000) with WHOQoL-BREF and positively (p=0.016) with PSQI.

Conclusion: The findings of this study indicate that the physical dependence of the child has a negative impact on the quality of life and sleep quality of caregivers, and that the number of siblings affects their satisfaction with the treatment. It is recommended that further information be obtained regarding caregivers' perceptions of the disease and their individual physical education needs, as a result of semi-structured individual interviews.

Keywords: Cerebral palsy, family, personal satisfaction, physical education, quality of life

SEREBRAL PALSİLİ ÇOCUKLARIN AİLE ETKİLENİMİ VE AİLEDEKİ BAKIM VERENİN YAŞAM KALİTESİ, UYKU KALİTESİ VE BİREYSEL BEDEN EĞİTİM MEMNUNİYETİNİN DEĞERLENDİRİLMESİ: KARMA ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Serebral Palsi (SP), hem çocuk hem de aile üzerinde önemli etkileri olan bir hastalıktır. Bu çalışmanın amacı, SP'li çocukların aile etkilenimini ve ailedeki bakım verenin yaşam kalitesini, uyku kalitesini ve bireysel beden eğitiminden (IPE) memnuniyetini incelemektir. Ayrıca yarı yapılandırılmış bireysel görüşmelerle de memnuniyetini etkileyen faktörlerin detaylandırılması planlanmıştır.

Yöntem: Çalışmaya 1-15 yaş aralığında SP tanısı almış 55 çocuğun bakım vereni dahil edilmiştir. Demografik bilgiler "Demografik Bilgiler Anketi" ile, çocuğun fonsiyonel durumu "Kaba Motor Fonksiyon Sınıflandırma Sistemi (KMFSS)" ile, çocuğun aile üzerindeki etkisi "Aile Etki Ölçeği (AEÖ)" ile, bakım verenin yaşam kalitesi "Dünya Sağlık Örgütü Yaşam Kalite Ölçeği – Kısa Form (DSÖYKÖ-KF)" ile, bakım verenin uyku kalitesi "Pittsburgh Uyku Kalitesi İndeksi (PUKİ)" ile ve bakım verenin çocuğunun aldığı bireysel bedensel eğitimden memnuniyeti "Pediatrik Yaşam Kalitesi Sağlık Bakımı Ebeveyn Memnuniyet Ölçeği (PYKSBEMÖ)" ile değerlendirilmiştir. Nitel veriler ise, yarı yapılandırılmış bireysel görüşmeler ile sağlanmıştır.

Sonuçlar: Çalışmamızda KMFSS seviyesinin DSÖYKÖ-KF ile negatif (p=0,028), PUKİ ile pozitif (p=0,002) korelasyon gösterdiği bulunmuştur. Ayrıca AEÖ ölçeği DSÖYKÖ-KF ile negatif (p=0,000), PUKİ ile pozitif (p=0,016) korelasyon göstermektedir.

Tartışma: Bu çalışmanın bulguları, çocuğun fiziksel bağımlılığının bakım verenlerin yaşam kalitesi ve uyku kalitesi üzerinde olumsuz bir etkiye sahip olduğunu ve kardeş sayısının tedaviden memnuniyetlerini etkilediğini göstermektedir. Yarı yapılandırılmış bireysel görüşmeler sonucunda bakım verenlerin hastalık algıları ve bireysel beden eğitimi ihtiyaçları hakkında daha fazla bilgi edinilmesi önerilmektedir.

Anahtar kelimeler: Serebral palsi, aile, kişisel memnuniyet, bedensel eğitim, yaşam kalitesi

INTRODUCTION

Cerebral palsy (CP) is the most prevalent disease affecting motor function in newborns (1). The child's motor functions and body development are affected as a result of various injuries and malformations in the developing central nervous system (2). As reported by Serdaroğlu et al. (2006) in a study conducted in Turkey, the incidence of this condition was found to be 4.4 per 1,000 live births (3).

Given that CP emerges in early infancy and continues through to adulthood, it is essential to consider and manage the process within the context of development, functionality and family (1). Children with CP require varying degrees of assistance to enable them to continue with their daily lives. The provision of care and assistance to children with CP has a significant impact on family caregivers, both physically and psychologically (2,4). In addition, having more than one child can have a negative impact on these stresses. A number of studies have investigated the impact of a child with CP on the family. These studies have reported that the burden of caregiving can cause stress, depression, sleep problems, reductions in quality of life and loss of motivation in family caregivers (2,5–7).

The nature of the disease, may necessitate lifelong education and treatment for children with CP. In order to achieve this objective, it is common practice to utilise the services of special education and rehabilitation centres. In special education and rehabilitation centres, the Physically Disabled Support Training Program is implemented under the Ministry of National Education. Individual physical education (IPE) is provided to patients with physical disabilities. IPE programmes are designed in accordance with the individual support training programme established by the Ministry of National Education. A individualised education programme is devised and implemented for each child (8).

The degree of satisfaction with the health service is an important indicator in evaluating the quality of the service provided. The satisfaction of family caregivers with the health care provided to their children is a key indicator of the quality of the service provided (9,10). A multitude of studies involving patients with diverse pathologies have reported that the therapeutic relationship between patient and therapist has a beneficial impact on health satisfaction (10).

A review of the literature revealed a paucity of studies evaluating the educational outcomes of children with CP. Given the potential influence of various demographic characteristics, quality of life, quality of sleep and the effects of the child with CP on the family on satisfaction with education, a comprehensive study was deemed necessary. Furthermore, it was postulated that the level of GMFCS of the child with CP may also be a contributing factor to the caregiver's satisfaction with the IPE.

The objective of this study is to examine the influence of the family, quality of life, sleep quality and IPE of family caregivers of children with CP. In addition, it is planned to detail the factors affecting their satisfaction through semi-structured individual interviews.

METHODS

Study Design and Participants

This study is a prospective mixed study using experimental and in-depth individual interview method in order to evaluate the effects of family caregivers who have children with CP and to evaluate the IPE satisfaction they receive from the special education and rehabilitation center. Approval for the study was obtained at the meeting of Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee dated 10/08/2022 (approval number E-10840098-772.02-4550) and the research was carried out in accordance with the Declaration of Helsinki.

Participants were selected from two different special education and rehabilitation centers in Turkey between August 2022 and May 2023. A multicentre trial was conducted in the same province in order to achieve the desired number of participants. The study included family caregivers of children aged between 1 and 15 years old who had been diagnosed with CP and who received regular intervention through the use of the IPE. The study sample was limited to caregivers with no more than one child with special needs, proficiency in Turkish, and no communication or cognitive difficulties. Evalu-

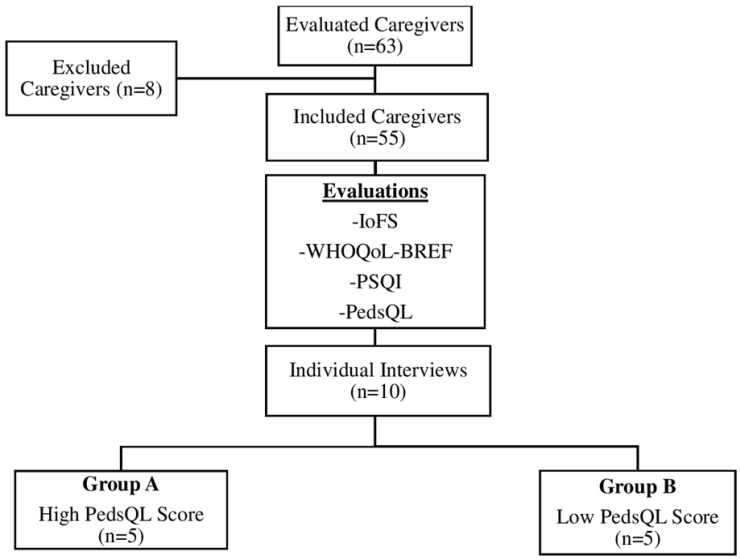

Figure 1. Flowchart of the Study

ations were made through questionnaires. A written consent form was furnished to respondents for review and signature before starting interviews. A total of 63 individuals participated in the study; however, due to the incomplete completion of eight questionnaires, the analyses were conducted on 55 participants. Flowchart is given in Figure 1.

Measures and Procedures

The demographic information of the family caregivers was questioned by the questionnaire prepared by the researcher. Each child's function level was recorded with the "Gross Motor Function Classification System (GMFCS)". The effect of the child with CP on the family was determined by the "Impact on Family Scale (IoFS)"; quality of life with "World Health Organization Quality of Life Scale – Short Form (WHOQOL-BREF)"; sleep quality with "Pittsburgh Sleep Quality Index (PSQI)"; satisfaction with IPE was questioned with the "Pediatric Quality of Life Health Care Parental Satisfaction Scale (PedsQL)". Qualitative data were obtained through semi-structured individual interviews.

Demographic Information Survey

A researcher-developed form was used to record demographic information about the family caregivers (degree of kinship, age, education level, occupation, marital status) and the child (number of siblings, gender, concomitant disease, age).

Gross Motor Function Classification System (GMFCS)

The GMFCS is a five-category motor classification tool that varies according to the age of the patient. The evaluation assesses the individual in a number of areas, such as mobility, posture and balance. As the level increases, functional independence decreases (11–13).

Impact on Family Scale (IoFS)

The questionnaire was originally developed by Stein and Riessman (14). The scale has a 4-point likert type evaluation and consists of a total of 33 items. In 2009, Bek et al. conducted a Turkish validity and reliability study. The study was deemed valid and reliable for children with special needs in Turkey, with the exception of the "Coping" subscale (15). A high score indicates family is highly affected by the situation (16).

World Health Organization Quality of Life Scale – Short Form (WHOQOL-BREF)

Developed by the World Health Organization (WHO), WHOQOL-BREF has 4 areas related to quality of life; physical health, psychological health, social relationships and environment (17). Turkish validity and reliability of the questionnaire was conducted by Eser et al. Turkey adaptation consists of 27 questions with the addition of 1 national question about the environment (18). Evaluation is graded

on a 5-point likert scale, a high score indicates a high quality of life (17,19).

Pittsburgh Sleep Quality Index (PSQI)

PSQI assesses sleep quality in the past month and factors that may affect sleep quality in adults (20). In 1996, Ağargün et al. conducted Turkish validity and reliability studies on PSQI (21). Of the 24 questions in total, 19 questions are answered by self-report and 5 questions are answered by the spouse or roommate. Within the scope of this study, only self-report questions were answered. It is evaluated with a 4-point likert scale, a total score greater than 5 indicates poor sleep quality (20).

Pediatric Quality of Life Health Care Parental Satisfaction Scale (PedsQL)

Scale, developed by James W. Varni et al. (22). Turkish validity and reliability studies were carried out in 2016 by Ulus and Kublay (23). It consists of 6 subtitles and 25 questions, including information, family involvement, communication, technical skills, emotional needs and general satisfaction. Evaluated with a 5-point likert scale and higher score means more satisfaction (23,24).

Semi-Structured Individual Interviews

Semi-structured individual interviews were conducted with 10 of the family caregivers included in the study, based on the results of the PedsQL survey in which we assessed satisfaction with IPE. In order to prevent bias in the study, semi-structured interviews were conducted with individuals exhibiting varying degrees of satisfaction. The 10 people to be interviewed included the 5 people with the lowest PedsQL scores (Group A) and the 5 people with the highest PedsQL scores (Group B) (25,26). The objective of the interviews is to gain a comprehensive understanding of patients' satisfaction with the treatment and to identify the underlying reasons. The questions posed in the interviews were constructed based on the clinical experiences of the researchers, expert opinions, and a comprehensive literature review. In order to ascertain the suitability of the draft questions, the opinion of an expert in the field was sought. The interviews were conducted online and recorded with the consent of the participants. Each interview lasted approximately 15 minutes.

Statistical Analysis

Power analysis was performed to determine the number of people to be included in the study. The power of the test was calculated with the G*Power 3.1 program. The data of our study were evaluated using the Statistical Package for Social Sciences (SPSS) 25.0 IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 22.0 (SPSS INC., Chicago, IL, USA).

A comparable study in the relevant literature is that conducted by Lang et al. (2021), which calculated the effect size for the relationship between sleep quality and quality of life as 0.480. In order to exceed the 95% value in determining the power of the study, it is necessary to reach 42 people at a 5% significance level and an effect size of 0.480 (lower critical r = 0.257; upper critical r = 0.257). In the research, the objective was to reach 50 people in each group, given the high power of the test and the anticipated losses (20).

Frequency and percentage analyze were used to determine the descriptive characteristics of the participants, and mean and standard deviation statistics were used to analyze the scale. Kurtosis and Skewness values were examined to determine whether the research variables showed a normal distribution. Parametric methods were used in the analysis of the data.

The relationships between the dimensions determining the scale levels of the patients were examined through Pearson correlation analyses. Correlation coefficients (r) 0.000-0.250 very weak; 0.260-0.490 weak; 0.500-0.690 medium; 0.700-0.890 high; 0.900-1.000 is rated as very high. Independent groups t-test, one-way analysis of variance (Anova) and post hoc (Tukey, LSD) analyzes were used to examine the differences in the scale levels according to the descriptive characteristics of the patients (27).

In order to analyse the qualitative data, the recorded interviews were initially transcribed into written form. In the study, the researchers employed descriptive analysis, which is one of the qualitative analysis methods. In descriptive analysis, the objective is to elucidate and delineate a specific situation or occurrence in accordance with pre-es-

tablished themes (28). Miles & Huberman (1994) reliability formula [Reliability = Consensus / (Agreement + Disagreement)] was used in the analysis of qualitative data, and the agreement between the researchers was determined as 88.75% (29). Miles and Huberman suggest that a qualitative study of sufficient quality should have a coding reliability of at least 80%. The results of the calculations show that the coding in this study is reliable.

RESULTS

The study included 55 family caregivers (4 Male/51 Female) who had CP (36 Boys/19 Girls) children and met the inclusion criteria. The majority of the family caregivers (89%) were mothers. The mean age of the caregivers was 39.380 ± 8.263 years, while the mean age of the children was 9.250 ± 4.660 years. The demographic information of the participants is provided in Table 1.

The distribution of GMFCS scores among the children of family caregivers who participated in the study is as follows: 23.6% are classified as level 1, 18.2% as level 2, 10.9% as level 3, 20.0% as level 4, and 27.3% as level 5. The results indicated that 56% of the participants exhibited poor sleep quality.

There was a statistically significant negative (p=0.028) correlation with the child's GMFCS level, the family caregiver's WHOQOL-BREF score, and a positive (p=0.002) correlation with the PSQI score. There was no statistically significant correlation between GMFCS level and IoFS and PedsQL scores (p>0.05).

There was no statistically significant relationship between the family caregivers's IoFS score and the education level (p=0.248), the total number of siblings of the child (p=0.582) and the concomitant disease of the child (p=0.899) (p>0.05).

There was no statistically significant relationship between the WHOQOL-BREF score of the caregivers and the educational level (p=0.693), the total number of siblings of the child (p=0.915) and the concomitant disease of the child (p=0.671) (p>0.05).

There was no statistically significant relationship between the caregiver's PSQI scores and the educational level (p=0.649), the total number of siblings of the child (p=0.960) and the concomitant disease of the child (p=0.406) (p>0.05).

There was no statistically significant relationship between PedsQL total and sub-parameter scores and the educational level of the caregiver and the child's concomitant disease (p>0.05). However, a difference was found between the total number of siblings of the child and the PedsQL total score of the family caregivers on the sub-parameters of

Table 1. Distribution of Participants by Demographic Information

Groups	n (%)
Degree of Kinship	
Mother	49 (89.10%)
Grandmother	2 (3.60%)
Father	4 (7.30%)
Parent's Education Level	
Primary School	18 (32.70%)
Middle School	10 (18.20%)
High School	13 (23.60%)
University	14 (25.50%)
Parent's Occupation	
Housewife	46 (83.6%)
Nurse	1 (1.80%)
Accountant	1 (1.80%)
Teacher	3 (5.50%)
Technician	1 (1.80%)
Self-Employed	3 (5.50%)
Marital Status of the Parent	
Married	53 (96.40%)
Not Married	2 (3.60%)
Number of Siblings	
1	16 (29.10%)
2	22 (40.00%)
3 or more	17 (30.90%)
Gender	
Boys	36 (65.50%)
Girls	19 (34.50%)
Concomitant Disease	
No	33 (60.00%)
Yes	22 (40.00%)
	Mean±SD
Parent's Age (year)	39.38±8.26
Child's Age (year)	9.25±4.66

SD: Standard Deviation

Table 2. Comparison of PedsQL Scores with Number of Siblings

	Group	n (%)	Mean±SD (N=55)	p
	1	16 (29.10%)	14.12±4.47	
Information	2	22 (40.00%)	15.59±5.01	0.172
	3	17 (30.90%)	12.05±7.42	
	1	16 (29.10%)	10.12±3.70	
Family Involvement	2	22 (40.00%)	13.40±3.55	**<0.05[a,b]**
	3	17 (30.90%)	10.11±5.84	
	1	16 (29.10%)	12.68±4.72	
Communication	2	22 (40.00%)	16.09±5.29	0.132
	3	17 (30.90%)	13.11±6.81	
	1	16 (29.10%)	10.62±3.98	
Technical Skills	2	22 (40.00%)	13.50±3.62	**<0.05[a,b]**
	3	17 (30.90%)	9.41±5.07	
	1	16 (29.10%)	11.50±4.06	
Emotional Needs	2	22 (40.00%)	13.60±3.55	**<0.05[a,b]**
	3	17 (30.90%)	9.41±5.42	
	1	16 (29.10%)	7.62±3.09	
General Satisfaction	2	22 (40.00%)	9.91±2.50	**0.052**
	3	17 (30.90%)	7.50±4.54	
	1	16 (29.10%)	66.68±20.22	
Total	2	22 (40.00%)	82.13±18.95	**<0.05[b]**
	3	17 (30.90%)	61.17±32.24	

PedsQL: Pediatric Quality of Life Healthcare Parental Satisfaction Scale, SD: Standard Deviation >: greater than, <: less than, [a]Significant change in favor group 2 compared with group 1, [b]Significant change in favor group 2 compared with group 3

family involvement, technical skills and emotional needs. The comparison of PedsQL scores with the number of siblings is given in Table 2.

The correlation analyzes between the evaluated scales are given in Table 3. When the analyzes were examined, statistically negative weak (p=0.028) between WHOQOL-BREF and GMFCS, negative moderate (p=0.000) between WHOQOL-BREF and IoFS, negative weak (p=0.011) between PSQI and WHOQOL-BREF, positive weak (p=0,002) correlation between PSQI and GMFCS, and a weak positive (p=0.016) correlation between PSQI and total IoFS. Correlation relationships between other variables were not statistically significant (p>0.05).

The responses to the individual interviews conducted using interview forms regarding the satisfaction of caregivers with the IPE received by children with CP were examined under four themes. These

Table 3. Correlation Analysis Between Scales

		GMFCS	IoFS	WHOQOL-BREF	PSQI	PedsQL
GMFCS	r	1.000				
	p	0.000				
IoFS	r	0.220	1.000			
	p	0.106	0.000			
WHOQOL-BREF	r	**-0.296***	**-0.512****	1.000		
	p	0.028	0.000	0.000		
PSQI	r	**0.412****	**0.322***	**-0.341***	1.000	
	p	0.002	0.016	0.011	0.000	
PedsQL	r	-0.132	-0.169	0.128	-0.054	1.000
	p	0.337	0.218	0.353	0.694	0.000

*<0,05; **<0,01; Pearson Correlation Analysis, GMFCS: Gross Motor Function Classification System, IoFS: Impact on Family Scale, WHOQOL-BREF: World Health Organization Quality of Life Scale – Short Form, PSQI: Pittsburgh Sleep Quality Index, PedsQL: Pediatric Quality of Life Healthcare Parental Satisfaction Scale

Table 4. Semi-Structured Individual Interview Results

THEMES	Highest PesdQL Scores (n=5)					Lowest PedsQL Scores (n=5)					
1. Opinions about disease diagnosis	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	Total (n=10)
I didn't want to accept the disease	x	x	x	x				x			5
As soon as I learned about the disease, I searched for a solution.					x	x	x		x	x	5
A1: *"I went to many different doctors. They were making the diagnosis, but I did not accept it and I went to another doctor. The acceptance process was very difficult. I cried constantly for a year."*											
2. Opinions on individual education	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	Total (n=10)
I feel good coming to the institution	x	x	x	x	x	x	x	x			8
A5: *"I go to the institution with hope every time, I never lose hope. Because the moment I lose hope, we are negatively affected."*											
I feel incomplete/guilty when we cannot come to treatment.	x	x	x	x			x	x		x	7
A2: *"I think that if we cannot go to treatment, my child's treatment will be negatively affected and I am not a good enough mother."*											
We get response from treatment	x	x	x	x	x		x			x	7
B2: *"We have been in this institution for 8-9 years, the treatment had positive aspects. You know, the treatment may last a lifetime, but the treatments are good."*											
I like to be involved in treatment		x			x	x				x	4
I make time for myself while my child is in session.	x		x		x		x	x	x		6
B1: *"I am always with the teachers during class. I ask at what angle I should do the movements, with what strength I should do them, how to protect my back and waist, everything."*											
3. Opinions about session times	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	Total (n=10)
Number of weekly sessions is insufficient	x					x	x	x	x		5
Number of weekly sessions is sufficient		x	x	x	x					x	5
B3: *"Our physiotherapist does the sessions very well, but it would be better if we could get more treatment."*											
4. Opinions about the person providing the education	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	Total (n=10)
I like our physiotherapist and find her/him adequate.	x	x	x	x	x		x	x			7
I think our physiotherapist needs to improve himself/ herself						x			x	x	3
B4: "Our physiotherapist changes frequently, so we find it difficult to adapt to the treatment."											

themes; are opinions about disease diagnosis, opinions on individual education, opinions about session times, opinions about the person providing the education. The results of the semi-structured individual interviews are presented in Table 4.

DISCUSSION

The study observed that the GMFSS score, which is a measure of the child's level of functioning, had a negative effect on the family caregivers' PSQI and WHOQoL-BREF, but did not have a statistically significant effect on IoFS and PedsQL. Furthermore, a positive correlation was observed between PSQI and IoFS, while a negative correlation was evident between PSQI and WHOQoL-BREF.

A study comparing the caregiving burden of parents of children with CP and parents of healthy children found that parents of children with CP reported more negative experiences (30). In developing countries such as Turkey, mothers typically assume the primary caregiving role for children with CP (12,30). It has been demonstrated that this can result in a decline in physical health and sleep quality among mothers of children with CP (30).

Majnemer et al. reported that the impact of the disease on the family was not associated with sociodemographic characteristics, but was highly associated with low GMFCS level (31). The results of this study demonstrate that there is no statistically significant correlation between family involvement

and either sociodemographic characteristics or the child's GMFCS level. The discrepancy in results between the aforementioned study and our own may be attributed to the fact that our study included a more limited population and a wider age range.

A review of existing studies has indicated that the quality of life of parents of children with CP is lower than that of parents of healthy children (12,32,33). However, the existing literature on the relationship between the GMFCS level of children with CP and the quality of life of mothers presents conflicting results. Some studies have indicated that this relationship is not statistically significant (30,34,35). The results of our study demonstrated a statistically significant negative correlation between the child's GMFCS level and the quality of life of the family caregivers. Additionally, there are studies in the literature that provide evidence to contradict the findings of our study (32,36). This can be attributed to the fact that children with low GMFCS levels require more assistance and support during their daily lives, which has a negative impact on their quality of life due to the additional burden on family caregivers.

In the existing literature, it has been reported that the quality of life of family caregivers may be affected by a number of factors, including the characteristics of their children, their own characteristics, environmental factors and/or their level of education (34,36). However, in contrast to the findings of previous studies, some research has indicated that there is no correlation between parental education level and the incidence of comorbidities in children, as well as the quality of life of the parents (19). When the results of our study were examined, it was seen that there was no correlation between the quality of life of the family caregivers and the education level of the family caregivers, the total number of siblings, and the child's concomitant illness. We also saw that the awareness of the family caregivers about the comorbidity was low and they primarily studied the dysfunctions caused by CP for the development of their children. Therefore, significant effects on quality of life may not have been observed.

A review of the literature on the sleep quality of parents with children with CP reveals that studies using similar methodologies have reported poor sleep quality in parents, with rates ranging from 71% to 40% (20,37,38). A total of 56.4% of caregivers who participated in the study reported poor sleep quality. This finding is consistent with previous research indicating that sleep problems are prevalent in caregivers of children with CP. It is crucial for healthcare professionals to recognise that this situation may have an impact on the treatment plan for the child.

It has been suggested that the level of satisfaction with the health services received by parents is an important factor in providing information about the quality and effectiveness of the treatment (39). A number of studies have indicated that having a greater number of children is positively correlated with parental satisfaction (9,39). The results of our study indicated that family caregivers with two children exhibited greater satisfaction than those with one child in the sub-parameters of family involvement and technical skill. This situation can be associated with the increase in satisfaction as the increasing number of children reduces the expectation from the treatment. Nevertheless, caregivers with two children exhibited greater satisfaction than caregivers with three or more children, as indicated by the PedsQL total score and sub-parameters pertaining to technical skill, emotional needs, and family involvement. This may be due to the fact that caregiver feel inadequate, due to the fact that having 3 or more children decreases the necessary care and attention on the child with CP. In our study, no significant relationship was found between health satisfaction and child GMFCS, family caregivers' quality of life and sleep quality.

When the literature was examined, it was seen that studies evaluating the education received by children with CP were insufficient. The various demographic characteristics of the family caregivers, their quality of life, sleep quality and the effects of the child with CP on the family; Considering that it may affect educational satisfaction, a comprehensive study was needed. In light of the aforementioned considerations, in addition to evaluating the caregivers with a survey, it was planned to detail the research data by conducting semi-structured individual interviews. As a result of the interviews, it was determined that the physiotherapist's pro-

fessional competence and approach to the child are important factors affecting treatment satisfaction. They reported that family caregivers who trust their physiotherapists feel more comfortable, happier and feel responsible during the treatment process.

In order to enhance the quality of education provided, it is imperative that the satisfaction and expectations of caregivers, who play a pivotal role in the treatment process of the child, are not overlooked (40). We believe that the treatment process will be positively affected when the demands of the caregivers and their satisfaction with the treatment are questioned by conducting individual interviews at regular intervals.

Limitations of our study are that there was no control group consisting of family caregivers with healthy children and the child's sleep quality was not evaluated.

The findings of our study indicated that the physical dependence of the child had a detrimental impact on the quality of life and sleep of the family caregivers, as well as their satisfaction with the treatment. The number of siblings was also found to influence the family caregivers' satisfaction with the treatment. It is recommended that further information be obtained through semi-structured individual interviews regarding family caregivers' disease perceptions and IPE needs. Authors think that family caregivers' satisfaction will increase when healthcare professionals work in partnership with patients and families.

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INVESTIGATION OF PSYCHOSOCIAL AND FUNCTIONAL DYNAMICS IN INDIVIDUALS WITH CHRONIC LOW BACK PAIN

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study was to compare the functional status, psychological status, quality of life and disability levels of individuals with chronic low back pain (LBP) of different origins with healthy individuals.

Methods: A total of 141 individuals, including healthy, nonspecific, non-radiculopathy and radiculopathy groups, participated in the study. Measurements included, the International Physical Activity Questionnaire, physical endurance tests, Visual Analogue Scale, Roland Morris Disability Questionnaire, Trait Anxiety Inventory, Fear Avoidance Beliefs questionnaire and Nottingham Health Profile.

Results: Psychological status, disability level and quality of life scores except anxiety level in individuals with chronic LBP differed significantly in the lowest nonspecific group and the highest in the radiculopathy group ($p<0.001$). Trunk extensor endurance showed a significant difference in favour of the healthy group compared to the other groups, whereas trunk flexion endurance showed a significant difference between all groups. A good correlation was found between the pain level of the patients with the quality of life and fear avoidance behavior, and a very good correlation was found with the disability level ($p<0.001$, $r=0.666$, $r=0.790$, $r=0.865$, respectively).

Conclusion: Due to the differences in the endurance levels and psychosocial situation between patients with low back pain, it is important to plan for the treatment taking into account both the physical and psychological needs of the individual change.

Keywords: Anxiety, fear, low back pain, quality of life

KRONİK BEL AĞRISI OLAN BİREYLERDE PSİKOSOSYAL VE FONKSİYONEL DİNAMİKLERİN İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı farklı kökenlere sahip kronik bel ağrısı olan bireyler ile sağlıklı bireyler arasında fonksiyonel durum, psikolojik durum, yaşam kalitesi ve dizabilite düzeyini karşılaştırmaktır.

Yöntem: Çalışmaya sağlıklı, nonspesifik, non-radikülopati ve radikülopati gruplarına dahil olan toplam 141 kişi katıldı. Ölçüm parametreleri olarak Uluslararası Fiziksel Aktivite Anketi, fiziksel endurans testleri, Görsel Analog Skala, Roland Morris Dizabilite Anketi, Sürekli Kaygı Envanteri, Korkudan Kaçınma İnançları anketi ve Nottingham Sağlık Profili kullanıldı.

Sonuçlar: Kronik bel ağrısı olan bireylerde anksiyete düzeyi dışındaki psikolojik durum, dizabilite düzeyi ve yaşam kalitesi puanları, en düşük nonspesifik grupta ve en yüksek radikülopati grubunda anlamlı farklılık gösterdi ($p<0,001$). Gövde ekstansör dayanıklılığı diğer gruplara göre sağlıklı grup lehine anlamlı farklılık gösterirken, gövde fleksiyon dayanıklılığı tüm gruplar arasında anlamlı farklılık gösterdi. Hastaların ağrı düzeyi ile yaşam kalitesi ve korkudan kaçınma davranışı arasında iyi bir korelasyon olduğu, dizabilite düzeyi arasında ise çok iyi bir korelasyon olduğu belirlendi ($p<0,001$, $r=0,666$, $r=0,790$, $r=0,865$, sırasıyla).

Tartışma: Gruplar arasındaki endurans düzeyi ve psikososyal durum farklılıklarından dolayı, bireyin hem fiziksel hem de psikolojik ihtiyaçlarının değiştiği göz önünde bulundurularak tedavinin planlanması önemlidir.

Anahtar Kelimeler: Anksiyete, korku, bel ağrısı, yaşam kalitesi

INTRODUCTION

Low back pain (LBP) is a symptom of pain or discomfort resulting from multifactorial etiology with anatomical, physiological, psychological and social consequences (1). LBP is one of the most common complaints in society. It is a syndrome that affects approximately 80% of the world's population at least once in their lives. Although considered to be the most common cause of absenteeism and activity restrictions, it is the second leading symptom in clinic admission (2,3). Various factors are involved in the development of LBP. The most common causes of LBP are structural and mechanical disorders. In a meta-analysis study, decreased trunk muscle endurance and strength were shown to be among the physical factors causing LBP (4). It is known that risk factors such as a decreased abdominal and back muscle strength and flexibility, decreased cardiovascular endurance, smoking and vibration, together with a heavy lifestyle are, associated with LBP (5). The limited effectivenes of treatments for LBP means that it is associated with many health problems such as reduced mobility and quality of life, poorer health status, disability and depression (3,6).

The transition of LBP to chronicity at the psychosocial level is influenced by two key factors: kinesiophobia and fear avoidance beliefs (7,8). The fear avoidance model is a conceptual framework that elucidates the relationship between patients' beliefs about illness, movement, and pain, and the formation of myths and misconceptions surrounding the painful experience. The avoidance of pain and hypervigilance are based on destructive thoughts that activate restrictive attitudes, which in turn increase disability and pain (8,9). Therefore, destructive thoughts are associated with fear of action, which in turn results in worse outcomes in therapeutic interventions (10). Oliveira et al. argue for the importance of identifying psychosocial risk factors in a multidisciplinary approach to the management of patients with LBP (11).There is an emerging consensus that psychosocial factors are of pivotal importance in the transition from acute to chronic LBP and that these may also be causal factors (12). It has been demonstrated in empirical studies that individuals with LBP exhibit elevated levels of anxiety and disability (13,14). Furthermore, it has been demonstrated that patients with chronic LBP exhibit significantly reduced muscle strength in the trunk flexor and extensor muscles (15). In previous studies, healthy individuals and individuals with chronic LBP have typically been compared according to different origins or examined according to pain level (16-18).

A further area for investigation is the manner in which physical and psychosocial symptoms change in accordance with the presence or absence of LBP-related pain and the different origins thereof. A better understanding of how psychosocial and physical variables develop according to different origins in individuals with LBP may inform the development of more effective treatment and prevention strategies for LBP. Furthermore, elucidating this information will assist in determining the psychosocial adaptation of the patient to the treatment, the necessity for multidisciplinary support, and the type and intensity of the exercise to be administered, according to the treatment groups that can be applied to the patients.

The objective of this study was to compare the functional status, psychological status and disability level among healthy individuals, patients with nonspecific low back pain, patients with lumbar disc herniation without root compression (radiculopathy) and lumbar disc herniation with root compression (radiculopathy).

METHODS

This cross-sectional study included individuals who presented to the Buyuk Anadolu Hospital Orthopaedics and Traumatology Clinic between February and June 2021 with complaints of lower back pain. The study population comprised 38 individuals with lumbar disc herniation (non-radiculopathy group), 35 individuals with non-specific low back pain (non-specific group), 36 individuals without low back pain (healthy individuals), and 32 individuals with radiculopathy due to root compression (radiculopathy group). The patients were examined by the same orthopaedic and neurosurgeon physician. Individuals in the healthy group were invited to participate in the study through announcements and were randomly selected from volunteers who had

no history of back problems who underwent both physical and radiological examinations. The MRI was analysed by the same radiologist, who was blinded to the clinical history of the patients and had experience in this field. Imaging was performed using a 1.5 Tesla MRI device. In cases where root compression was suspected, an electromyogram (EMG) was requested. The same physiotherapist evaluated the endurance tests and measurement tools of all participants. In order for the endurance tests to be performed correctly, it was necessary to ascertain that the individual's pain intensity was less than approximately 5 cm, as assessed using a standard 10 cm visual analog scale (VAS). An informed consent form was signed by all participants before inclusion. The study was approved by the local Ethics Committee (YDU/2020/83-1161).

In order to be included in the study, participants were required to meet the following criteria:

- Individuals aged between 20-65 for all groups
- The examination, laboratory and radiology examinations did not reveal any additional lumbar pathology in the nonspecific group
- In the non-radiculopathy group, only lumbar disc herniation was detected in the MRI,
- Individuals with LBP complaints for at least three months or longer were included in the nonspecific, non-radiculopathy and radiculopathy groups. Individuals who met any of the following criteria were excluded from the study: History of back and lower extremity surgery or trauma
- For the non-radiculopathy group, those with root compression findings
- For the nonspecific and healthy group, additional lumbar pathology was identified through examination and radiological examinations.
- Neurological, vestibular disorder, spinal abnormality, LBP of rheumatological origin
- For healthy individuals, those who have experienced LBP in the last year before participation and have had an attack of LBP lasting more than three months in the past
- Individuals who receive low back treatment were excluded from the study.

Data Collection Tools

Functional Status

Endurance Tests

The Biering-Sorensen test was used to evaluate the endurance of the trunk extensor muscles, while the trunk flexor endurance test was used to evaluate the endurance of the trunk flexor muscles. The endurance of the spinal stabiliser trunk muscles was evaluated using the lateral bridge test and the prone bridge test (19-21). The tests were conducted under the supervision of the same physiotherapist, with a three-minutes rest interval between each test. The time spent by the participant maintaining their position was recorded in seconds.

International Physical Activity Questionnaire

The physical activity level of the cases was determined by means of the Turkish version of the short form of the International Physical Activity Questionnaire (IPAQ). The questionnaire was found to be valid and reliable by Saglam et al (22).

Disability Level

Roland–Morris Disability Questionnaire

The Roland-Morris disability questionnaire consists of 24 statements based on the patient's perception of LBP and related disability. These items were reported as physical activity (15), sleep/rest (3), psychosocial (2), home management (2), eating (1) and pain frequency (1) (23). This test is based on measuring how LBP affects the patient's activities of daily living. Yes answers are scored as '1' and no answers scored as '0' points, resulting in a total score of 0-24. A higher score indicates greater disability. Turkish validity was carried out by Kucukdeveci AA et al (24).

Health-Related Quality of Life

Nottingham Health Profile

It consists of 6 parts: physical mobility, pain, sleep, energy level, emotional reactions and social isolation. This one-page questionnaire consists of 38 questions that are answered 'yes' or 'no'. The best score is '0' and the worst score is '100' (25).

Psychological Status

Trait Anxiety Inventory

The Trait Anxiety Form (A-Trait), which was adapted to Turkish and standardised by Öner and Le Compte, was used in the study. The inventory, comprising 20 items, was used to ascertain anxiety levels, with higher scores indicative of elevated anxiety (26).

Fear Avoidance Beliefs Questionnaire

The evaluation of fear avoidance beliefs related to the effects of physical activity and occupational tasks was carried out with the 'Fear Avoidance Beliefs Questionnaire comprising 16 items. A total score approaching zero indicates a reduction in fear avoidance behavior within the section, whereas a maximum score indicates an increase in such behavior (27).

Statistical analysis

Data obtained in the study were analyzed statistically using SPSS vn. 23 software (IBM, Chicago, IL, USA). A minimum of 16 individuals were required to be included in the study in each group, according to the 95% confidence (1-α) and 95% test power (1-β) f= 0.550 effect size parameters. This resulted in a total of 64 individuals being included in the study. According to the Post Hoc Power analysis, the power of the test was determined as 99.9% with 141 people (28). Mann Whitney U test, which is one of the non-parametric methods, was used for comparisons according to men and women. Spearman's rho value was used for correlation. The results of the correlation analysis were classified according to following criteria: very poor (0.00–0.20), poor (0.21–0.40), moderate (0.41–0.60), good (0.61–0.80), or very good (0.81–1.00). The data are presented as mean ± standard deviations and correlation coefficients (r). the level of the statistical significance was set at $p < 0.05$.

RESULTS

A total of 158 subjects were initially screened for eligibility, and 17 were subsequently excluded due to failure to meet the established inclusion criteria. Of these, 10 were from the healthy group and reported a history of LBP within the past year while 7 had herniation on MRI. The study was completed with 141 people (Figure 1).

Table 1 presents IPAQ scores, which indicate the physical activity levels of the groups, as well as demographic and physical characteristics. The demographic and physical characteristics of the groups are compatible with each other. Furthermore, the

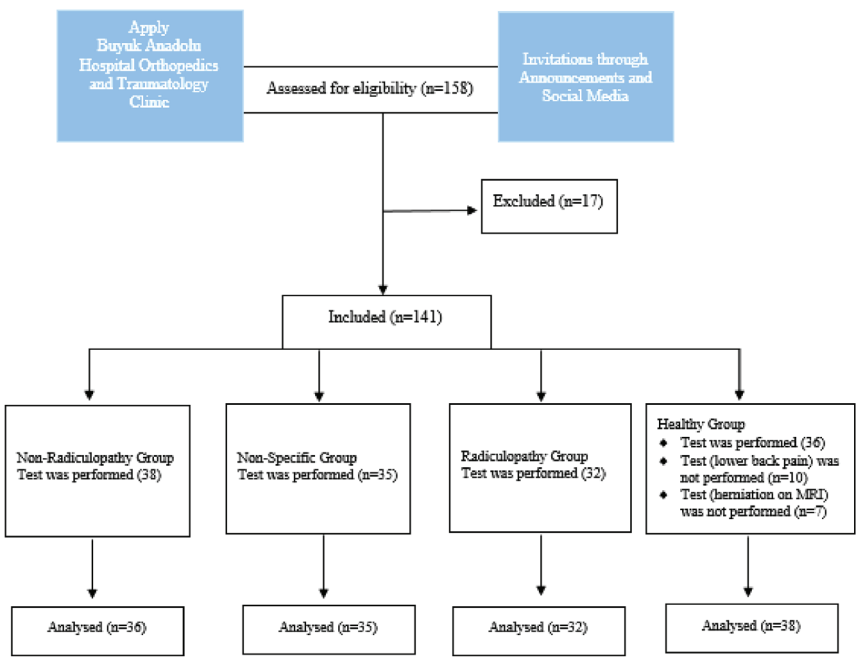


Figure 1. Selection of the Individuals Recruited for the Study and Group Formation

Table 1. Physical and Demographic Characteristics of the Groups

	Healthy Group	Nonspecific Group	Non-radiculopathy group	Radiculopathy group	Total	p
Age	38.28 ± 12.8	39.66 ± 12.88	39.79 ± 13.62	40.59 ± 11.49	39.55 ± 12.66	0.899
BMI	25.73 ± 3.65	26.22 ± 5.02	26.32 ± 4.81	27.75 ± 4.13	26.47 ± 4.46	0.289
Sex						
Male	16 (44.4)	16 (45.7)	18 (47.4)	15 (46.9)	65 (46.1)	0.995
Female	20 (55.6)	19 (54.3)	20 (52.6)	17 (53.1)	76 (53.9)	
IPAQ	4393.97 ± 5394	4131.29 ± 1975.77	5077.54 ± 7916.94	4537.23 ± 3469.93	4545.5 ± 5251.52	0.890

IPAQ: International Physical Activity Questionnaire, BMI: Body Mass Index

physical activity level of the groups was similar.

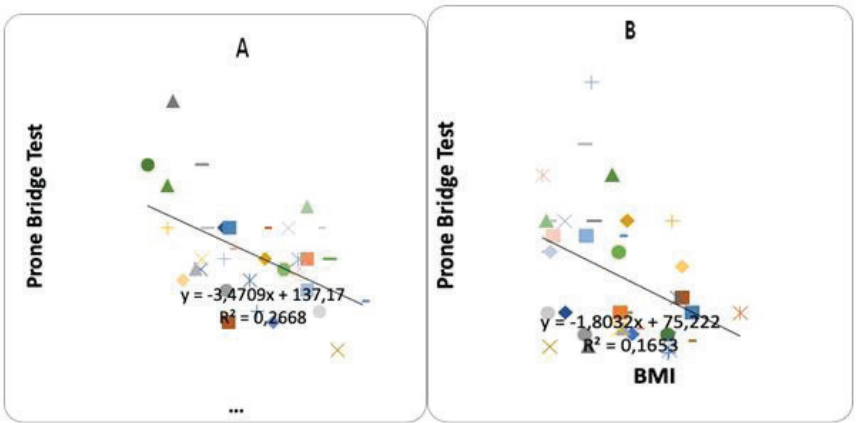
With regard to the pain intensity experienced by the groups, the radiculopathy group reported the levels of pain intensity at rest and during activity, while the nonspecific group exhibited the lowest levels (Table 2). A moderate negative correlation was found between the prone bridge test score and BMI in the healthy group and non-radiculopathy group (r= -0.518, r=-0.407, respectively) (Figure 2).

A positive good correlation was observed between VAS rest and VAS activity scores with quality of life and fear avoidance. Furthermore, a positive very good correlation was found with the disability level. However, no relationship was no relationship observed between VAS rest and VAS activity scores and anxiety levels (Table 2).

The mean values of the lateral bridge test (p=0.00), prone bridge test (p=0.00) and trunk flexion test (p=0.00), differed significantly (p<0.05) between the sexes in relation to quality of life (p=0.03) and anxiety level (p=0.026).. The mean values of quality of life (mean k: 88.7, m: 70.3) and anxiety level (mean k: 43, m: 42) were higher in women, whereas the mean values of the lateral bridge test (mean k: 10, m: 20), prone bridge test (mean k: 15, e: 40) and trunk flexion test (mean k: 12.5, e: 20) were higher in males.

Psychological state

An examination of the anxiety levels of the groups revealed no significant difference between the nonspecific group and the radiculopathy group in individuals with chronic low back pain. However, a significantly higher difference was observed in the non-radiculopathy group compared to the other groups (p=0.04) (Table 3). The lowest level of quality of life was observed in the radiculopathy group, while the highest was observed in the nonspecific group among patients with chronic low back pain. No significant difference was observed between the nonspecific and non-radiculopathy groups in quality of life scores. However, a significant difference was observed between the radiculopathy group and the other groups (p<0.001) (Table 3). The mean values of fear avoidance scores



A: Healthy group, B: Non-radiculopathy group, BMI: Body Mass Index

Figure 2. The Relationship Between the Prone Bridge Test and BMI

Table 2. Correlation Analysis Results of the Evaluated Parameters

		Quality of Life	Anxiety Level	VAS Rest	VAS Activity	Disability Level
Quality of Life	r					
	p					
Anxiety Level	r	0.347				
	p	**<0.001**				
VAS Rest	r	0.602	0.085			
	p	**<0.001**	0.313			
VAS Activity	r	0.666	0.132	0.957		
	p	**<0.001**	0.118	**<0.001**		
Disability Level	r	0.508	0.055	0.831	0.865	
	p	**<0.001**	0.516	**<0.001**	**<0.001**	
Fear Avoidance	r	0.484	0.005	0.734	0.790	0.797
	p	**<0.001**	0.951	**<0.001**	**<0.001**	**<0.001**

VAS: Visual Analog Scale

are presented in Table III. A significant difference was observed between all groups in terms of fear avoidance score. The lowest fear avoidance scores were observed in the nonspecific group, while the highest scores were observed in the radiculopathy group (p<0.001) (Table 3).

Disability level

A comparison of the disability levels of patients with LBP revealed that, the lowest score was observed in the nonspecific group, while the highest score was noted in the radiculopathy group. A significant difference was observed between all groups (p<0.001) (Table3).

Functional status

A comparison of the lateral bridge test scores revealed no statistically significant difference between the groups (p>0.05). While the prone bridge test and Biering-Sorenson test scores were found to be significantly different between the healthy group and the other groups, no such difference was observed between the nonspecific and non-radiculopathy groups. A significant difference was ob-

Table 3. Comparison of Parameters According to Groups

	Healthy Group (n=36)	Nonspecific Group (n=35)	Non-radiculopathy Group (n=38)	Radiculopathy Group (n=32)	P
Pain intensity					
VAS rest	---	2 (0 - 4)[a]	3 (0 - 5)[a]	7 (1 - 10)[b]	**<0.001**
VAS activity	----	3 (0 - 5)[a]	5 (0 - 5)[b]	9 (3 - 10)[c]	**<0.001**
Psychological state					
Anxiety Level	42.72 ± 1.56[a]	44.2 ± 4.22[b]	45.39 ± 5.01[c]	44.22 ± 4.1[b]	**0.041**
Fear Avoidance	---	9.34 ± 12.15[a]	20.63 ± 15.92[b]	36.25 ± 21.43[c]	**<0.001**
Level of disability	---	1.66 ± 2.46[a]	5 ± 5.06[b]	17.09 ± 5.68[c]	**<0.001**
Quality of Life	---	61.12 ± 88.79[b]	98.79 ± 85.62[b]	166.88 ± 74.53[a]	**<0.001**
Functional status					
LBT	19.94 ± 9.13[a]	17.77 ± 8.48[a]	16.95 ± 12.89[a]	-	**>0.05**
PBT	47.56 ± 23.48[c]	28.34 ± 16.75[b]	27.76 ± 21.31[b]	-	**<0.001**
BST	21.81 ± 9.94[c]	17.17 ± 9.05[b]	13.84 ± 11.82[b]	-	**<0.001**
TFT	27.92 ± 13.96[a]	21.91 ± 11.91[b]	13.89 ± 9.69[c]	-	**<0.001**

[a-c] There is no difference between groups with the same letter for each line. LBT: Lateral Bridge Test, PBT: Prone Bridge Test, BST: Biering-Sorenson Test, TFT: Trunk Flexion Test

served between all groups in the trunk flexion test ($p<0.001$) (Table 3).

DISCUSSION

The main finding of our study is that the functional and psychological dynamics differed between groups. While other psychosocial parameters with the exception of anxiety level, exhibited parallel changes in relation to pain severity, trunk flexion endurance demonstrated divergence across all groups.

The activation of the pituitary gland is responsible for the initiation stress process, which is triggered by the presence of pain. Accordingly, the onset of the process in low back pain is associated with stress factors, as evidenced by the correlation between the frequency or intensity of the pain and these factors (29). While some of the hormones secreted during stress have a protective effect on the body, others render the body more susceptible to trauma and psychological distress (30). The last decade has seen a growing emphasis in research on the multidimensional nature of LBP, with a particular focus on the psychosocial dimension. A substantial body of research has demonstrated that individuals with chronic LBP experience emotional difficulties, including depression, anxiety, and hopelessness (31). The current evidence base identifies psychosocial factors as significant determinants of LBP and emphasizes their role in the transition from recent onset pain to persistent pain (32). The results of various studies indicate that psychosocial factors including fear of pain, pain, disability, depression and catastrophizing, influence the clinical profile and prognosis in individuals with LBP (33). In our study, an examination of the psychosocial factors according to the different origins of individuals with LBP revealed that the highest levels of anxiety were observed in the non-radiculopathy group, while the highest levels of fear avoidance behavior were observed in individuals with radiculopathy.

Santos et al. found that the cause of functional decline in patients with LBP was anxiety and stress, and that levels of stress, depression, anxiety and dysfunction were higher in older patients with LBP (13). Similar to the results of this study, higher levels of anxiety and disability were also observed in other groups compared to healthy individuals in the current study. In addition, several studies have shown a strong relationship between pain-related fear and disability in individuals at different stages of the transition from acute to chronic pain (34). In parallel with the results of these studies, our study found a strong correlation was found between pain severity and disability and fear avoidance behavior.

In their study, Garbi et al. established a correlation between pain intensity with disability, as well as depression level (14). The findings of the present study indicate that individuals with radiculopathy and high levels of pain exhibited a higher disability level than those without radiculopathy. Conversely, the non-radiculopathy group demonstrated elevated anxiety levels. This result can be attributed to the fact that in the radiculopathy group, the patient focused on the pain and distanced themselves from other sources of distress due to the severe pain experienced. In contrast, in the non-radiculopathy group the patient focused on the physical and psychosocial difficulties caused by the persistence of this condition.

In a previous study, Cho et al. demonstrated that patients with chronic LBP exhibited significantly reduced muscle strength in both the trunk flexors and extensors when compared to a healthy group (15). Furthermore, an increased BMI and a reduction in trunk muscle strength were found to be directly correlated with chronic LBP (35). In the current study, the trunk endurance values of the nonspecific LBP and non-radiculopathy groups were significantly lower than the healthy group, similar to the results of previous studies. Moreover, Bohannon et al. suggested that enhanced prone bridge performance would be associated with reduced abdominal adipose tissue. A similar correlation was observed between prone bridge performance and BMI in the healthy and non-radiculopathy group as was the case in the present study (36). Abdominal region body mass ratio and waist circumference may play a role in the absence of this relationship in the nonspecific group. A review of the literature revealed no studies that had compared the trunk endurance values of individuals with nonspecific LBP and individuals with lumbar disc herniation. The results of the study did not differ between the two groups in the prone bridge and Biering-Soren-

son tests, but did differ in the trunk flexion test. The higher frequency and duration of pain in the non-radiculopathy group may have been a contributing factor to this result. Given that trunk flexion endurance is more susceptible to decline in individuals with lumbar disc herniation, it is crucial to prioritise exercises that enhance the endurance of trunk flexor muscles in treatment programmes.

The limitation of the study was the inability to compare measurement data according to age decades due to the insufficient number of participants. Additionally, waist circumference measurement, which could have augmented the reliability of BMI measurement data, was not conducted on individuals.

CONCLUSION

The results of this study indicate that there were significant differences in functional and psychological parameters differed between the various groups. While psychosocial parameters other than anxiety levels demonstrated variation in relation to the severity of pain, it was observed that anxiety level was higher in the non-radiculopathy group. Of particular clinical relevance is the observed difference in trunk flexion endurance among all groups. It is therefore recommended that greater emphasisbe placed on increasing trunk flexor muscle endurance in patients with chronic low back pain. In terms of trunk flexor muscle endurance, physical evaluation of patients with nonradiculopathy and nonspecific low back pain, whose treatment programs are generally continued without separation, is of critical importance to shed light on the treatment. Given the discrepancies in endurance levels and psychosocial profiles across the groups, it is crucial to devise a treatment plan that considers the evolving physical and psychological needs of the individual.

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Author Contributions: TY, AY and AÖ designed the study, interpreted the data, and made major contributions to the writing of the article. AY evaluated the suitability of the patients and referred potential participants to the polyclinics. All authors read and approved the final version of the manuscript.

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EFFECTS OF PILATES EXERCISES AND WHOLE-BODY VIBRATION EXERCISES TRAINING ON BODY COMPOSITION, FLEXIBILITY, AND BALANCE IN HEALTHY WOMEN: RANDOMIZED CONTROLLED PILOT STUDY

ORIGINAL ARTICLE

ABSTRACT

Purpose: This study aims to compare the effects of pilates and whole-body vibration exercise training on body composition, flexibility, balance, and functional strength of core muscles in healthy women.

Methods: Thirty-six healthy women were divided into three groups: a pilates group, a whole-body vibration (WBV) exercise group, and a control group. The pilates group received training using the 'Reformer®,' while the WBV group used the 'Power Plate®.' Both groups trained twice a week for eight weeks, with sessions lasting 45-60 minutes each. The control group did not receive any training. Body composition was assessed using body mass index (BMI), the waist-to-hip ratio, and bioelectrical impedance analysis. Sit-and-Reach Test for flexibility, Functional Reach Test for balance, and Sit-ups and Modified Push-ups Test for core muscle strength. Assessments were made before and after training.

Results: In the group comparisons, significant differences in BMI and some bioelectrical impedance parameters were observed in the WBV group ($p<0.05$). However, no significant changes in body composition were found in the pilates and control groups and no difference was found between the three groups ($p>0.05$). Flexibility showed significant differences among the three groups ($p<0.01$). Functional core strength increased in both the pilates and WBV groups ($p<0.05$), but no significant differences were observed in balance and strength comparisons between the groups ($p>0.05$).

Conclusion: Results indicate that WBV training affected body composition, and both exercise groups improved flexibility, balance, and core strength. However, WBV was not superior to pilates. Further research is needed for generalizability.

Keywords: Balance, Body composition, Core muscles, Exercise, Physiotherapy and Rehabilitation.

SAĞLIKLI KADINLARDA PİLATES EGZERSİZLERİ VE TÜM VÜCUT VİBRASYON EGZERSİZ EĞİTİMİNİN VÜCUT KOMPOZİSYONU, ESNEKLİK VE DENGE ÜZERİNDEKİ ETKİLERİ: RANDOMİZE KONTROLLÜ PİLOT ÇALIŞMA

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı sağlıklı kadınlarda pilates ve tüm vücut vibrasyon egzersizlerinin vücut kompozisyonu, esneklik, denge ve çekirdek kasların fonksiyonel gücü üzerine etkilerini karşılaştırmaktır.

Yöntem: Otuz altı sağlıklı kadın üç gruba ayrıldı: Pilates grubu, Tüm Vücut Vibrasyon (TVV) grubu ve kontrol grubu. pilates grubu "Reformer®" kullanarak eğitim alırken, TVV grubu "Power Plate®" kullandı.Her iki grup da sekiz hafta boyunca haftada iki kez 45-60 dakika eğitim aldı. Kontrol grubu ise herhangi bir eğitim almadı. Katılımcıların vücut kompozisyonu; vücut kütle indeksi, bel-kalça oranı ve biyoelektriksel impedans analizi ile değerlendirildi. Esneklik için "otur-uzan testi", denge için "fonksiyonel uzanma testi", çekirdek kas kuvveti için ise "sit-ups ve modifiye push-ups testi" uygulandı. Değerlendirmeler eğitim öncesi ve sonrasında yapıldı.

Sonuçlar: Gruplar arası karşılaştırmalarda, TVV grubunun vücut kütle indeksi ve bazı bioelektriksel impedans analiz parametrelerinde istatistiksel olarak anlamlı farklar gözlendi ($p<0,05$). Pilates grubu ve kontrol grubunda ise vücut kompozisyonu verilerinde anlamlı farklar görülmedi ve üç grup arasında fark bulunmadı ($p>0,05$). Esneklik açısından ise üç grup arasında istatistiksel olarak anlamlı fark saptandı ($p<0,01$). Çekirdek kaslarının fonksiyonel kuvveti hem Pilates grubunda hem de TVV grubunda arttı ($p<0,05$), ancak hiçbir grup için karşılaştırmalarda denge ve fonksiyonel kuvvet açısından istatistiksel fark bulunmadı ($p>0,05$).

Tartışma: Sonuçlar, TVV egzersiz eğitiminin vücut kompozisyonu etkilediği, esneklik, denge ve kor kaslarının fonksiyonel kuvvetini artırmada her iki eğitim grubunun da etkili olduğu ancak TVV egzersiz eğitiminin Pilates egzersiz eğitimine üstünlüğü olmadığını göstermektedir. Bu sonuçların genellenebilirliğini değerlendirmek için daha fazla araştırmaya ihtiyaç duyulmaktadır.

Anahtar Kelimeler: Denge, Vücut Kompozisyonu, Kor Kasları, Egzersiz, Fizyoterapi ve Rehabilitasyon.

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INTRODUCTION

The World Health Organization (WHO) defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." In contemporary times, the essence of a healthy lifestyle involves maintaining both physical and mental activity, adopting a balanced and nutritious diet, refraining from smoking and excessive alcohol consumption, and effectively managing stress (1).

In recent years, various factors such as desk-bound work and technology addiction have contributed to sedentary lifestyles. Sedentary living represents a significant global issue, with adverse impacts on societies, including weight gain and an escalation of chronic ailments. Recent global estimates indicate that 1.4 billion adults, representing 27.5% of the world's adult population, fail to meet the recommended levels of physical activity for improving and maintaining their health (2). Consequently, enhancing physical activity is pivotal to averting chronic diseases and promoting healthy aging. Participating in exercise and sports remains the most effective approach to heighten physical activity levels (3).

Pilates and whole-body vibration (WBV) training have emerged as prominent and intriguing exercise methodologies in recent times. The pilates method, developed by American physical trainer Joseph Hubertus Pilates (1880-1967) in New York, represents a fusion of balance, breathing, and movement systems founded on the symbiosis of mind and body. As pilates emphasizes the role of cognitive control over muscles, it is often termed "Contrology." Executed at a deliberate pace and demanding mental engagement, pilates movements prioritize both the activation of "core" muscles and the precision and command of the executed motions (4).

WBV constitutes a neuromuscular training technique involving the application of mechanical stimulation through systemic vibration signals. For numerous years, low-amplitude, low-frequency vibration has been advocated as a beneficial adjunct to exercise for enhancing physical fitness (5). In WBV, mechanical and sinusoidal vibrations are transmitted through a platform beneath the feet to the entire body. WBV facilitates static and dynamic exercises alike and finds applications in physiotherapy as well as among professional athletes. Multiple studies have demonstrated that WBV can enhance muscular strength, flexibility, and bone density, while concurrently refining proprioception and balance (5,6).

WBV and pilates training have gained significant popularity as methods implemented in wellness centers in recent years. While several studies have demonstrated the impact of these individual methods, there exists only a solitary study that directly contrasts them (7). This particular study focused on post-menopausal women and revealed that both WBV and Pilates training hold equal efficacy in preserving mineral bone density. Nonetheless, beyond this specific investigation, a dearth of research exists comparing the influences of these training approaches on aspects such as body composition, flexibility, and balance.

The aim of this study is to comprehensively compare the effects of both Pilates exercises and Whole-Body Vibration training on body composition, flexibility, balance, and functional strength of core muscles among healthy individuals, who commonly resort to these methods for physical appearance enhancement. For this purpose, three different hypotheses have been formulated in our study to investigate whether both types of training have an effect on the researched parameters and to examine whether one has superiority over the other.

METHODS

Subjects

In this research, a randomized-control study design was employed. Our study was conducted on sedentary women who applied to a private Health Center in Ankara, Turkey between August 2018 and December 2018, did not have any health problems, and voluntarily agreed to participate in the study.

Inclusion Criteria:

- Individuals aged between 25-45 years.
- Individuals who had not engaged in regular exercise over the preceding six months.
- Individuals with a moderate level of physical ac-

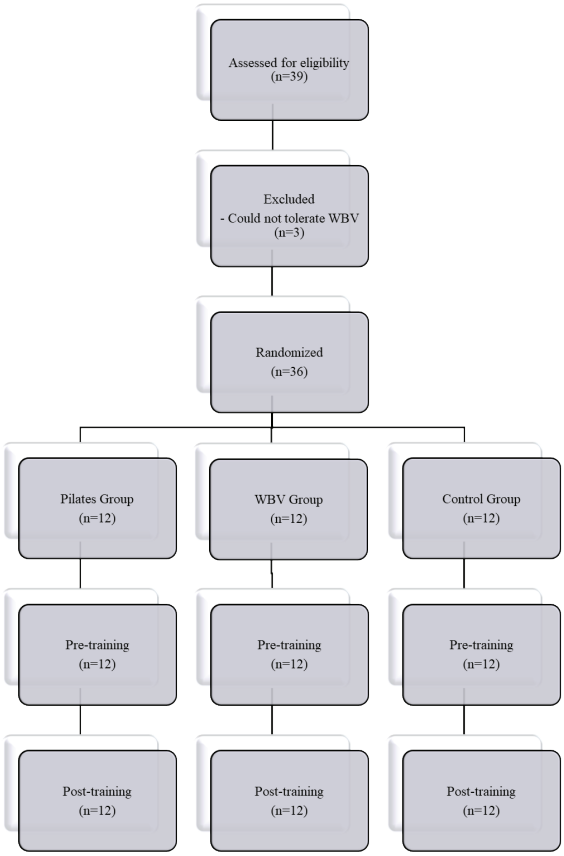

Figure 1. Flow Chart of the Study

tivity moderate level ranging from 600 to 3000 MET minutes/week (Metabolic Equivalent minutes/week), as assessed using the "International Physical Activity Questionnaire".

• Individuals with a body weight below 130 kg.

Exclusion Criteria:

• Individuals with a history of malignancies.

• Pregnant individuals.

• Individuals afflicted with musculoskeletal pain stemming from orthopedic or rheumatic conditions.

• Individuals with a recent history of fractures within the past year.

• Individuals diagnosed with neurological disorders (e.g., stroke, epilepsy).

• Individuals with chronic kidney or liver ailments.

• Individuals with cardiovascular conditions (e.g., cardiac arrhythmia, cardiac insufficiency).

• Individuals suffering from imbalance linked to a peripheral vestibular disorder diagnosis (such as Benign Paroxysmal Positional Vertigo or Meniere's disease).

• Individuals' incapable of tolerating WBV for more than five minutes.

This study was carried out with the requisite authorization from the Başkent University Medical and Health Sciences Research Board and Non-Invasive Clinical Research Ethics Board (approval date: 19/09/2018, reference: KA18/268). Additionally, written informed consent was obtained from all participants before their enrollment in the study.

Sample Size Calculation: Prior to initiating the study, a sample size and power analysis was performed using G* power software. Based on the "primary measurement" of "body fat ratio," an appropriate sample size was determined to achieve 90% statistical power with a 0.05 margin of error. Consequently, an initial total of 30 subjects were established, with an allocation of 10 subjects in each group. To account for a potential data loss of

20% during the study, the sample size was adjusted with a 20% surplus. Therefore, the final number of participants in the study was determined to be 36, with each group consisting of 12 subjects (8). After the study, analyses based on body fat percentage, which is also a product measurement, revealed significant differences between the groups at 98% power and 0.05 significance level.

Before starting the study, the subjects were asked to stay in a slight squat position without moving for 30 seconds to test whether they could tolerate WBV. Subjects who could tolerate it were randomly divided into three groups using the "Random Online Allocation Software" (www.Graphpad.com) (Figure 1).

Group 1: Pilates training group

Group 2: WBV exercises training group

Group 3: Control group

Outcome Measures

The subjects taking part in the study were assessed before starting the training program and at the end of the 8-weeks program.

The following assessment parameters were employed in the study:

- Sociodemographic variables
- Physical activity level
- Body composition
- Flexibility
- Balance
- Functional strength of core muscles

Sociodemographic Variables

Data encompassing sociodemographic aspects such as age, weight, height, education level, and occupation were gathered at the initiation of the study.

Physical Activity Level

The abbreviated version of the "International Physical Activity Questionnaire" in Turkish was administered to study participants to ascertain their physical activity levels, as stipulated by the inclusion criteria, and to confirm their moderate level of physical activity.

This concise form encompasses seven questions and elucidates factors including sitting duration, walking, activities of moderate intensity, and time allocated to vigorous activities. In terms of scoring, individuals are categorized as follows: those with <600 MET-min/week are regarded as physically inactive, those with 600-3000 MET-min/week demonstrate a low physical activity level, and those with >3000 MET-min/week possess a satisfactory level of physical activity. Individuals with a weekly physical activity score within the range of 600-3000 MET-min/week (moderate level) were eligible for inclusion in our study (9, 10).

Body Composition

The study employed Body Mass Index (BMI), waist-hip ratio, and bioimpedance analysis to ascertain body composition.

Body Mass Index (BMI)

Calculated as the weight in kilograms divided by the square of the height in meters. The height measurement was conducted using a stadiometer, which is a standard measurement method. (11).

Waist-Hip Ratio

Waist circumference was measured over the umbilicus and at the lowest costal level, while hip circumference was measured at the widest point of the posterior hip. These measurements were then proportionally related to each other (12).

Bioimpedance Analysis (BIA)

The Tanita BC 601 device (Tanita Corp., Maeno-Cho, Tokyo, Japan) was employed to quantify body fat and muscle proportions for assessing body composition. This professional body analysis instrument incorporates eight polar electrodes, with two electrodes allocated to each limb. Utilizing a 50 kHz, 0.8 mA electric current, the device measures the body's resistance during the current's passage through tissues. This process enables the determination of fat and muscle quantities. During BIA measurements, participants were instructed to wear lightweight attire.

Participants were directed to stand on the device's plantar electrodes with bare feet and to grasp the

hand-held component of the apparatus with flexed elbows. Upon the completion of measurements, data encompassing muscle weight, fat weight, fat percentage, and lean mass were documented by generating a printout from the device (12,13).

Flexibility

Flexibility is divided into two categories: static and dynamic. Dynamic flexibility is associated with sports and is difficult to measure. Therefore, flexibility is generally evaluated statically (14, 15). Evaluation can be done through direct or indirect methods. In direct evaluation, instruments such as a goniometer, flexometer, or inclinometer are used. The reliability and validity of direct measurement depend on the skill of the evaluator and the joint being measured. The commonly used indirect measure of flexibility is the Sit and Reach Test. While it does not reflect overall body flexibility, it evaluates hamstring, gastrocnemius and lower back flexibility. Therefore, the "Sit and Reach Test" was used to assess flexibility. This evaluation involved the use of a sit and lie board measuring 30 cm in height, 45 cm in width, and 100 cm in length. The reference point "0" was designated at the 25 cm inner section of the sit and reach board, where participants positioned their feet. The region closer to the individual from this reference point represented negative values, while the farther side indicated positive values. Individuals were acquainted with the test and instructed to perform two trials. During the test, participants were guided to prevent knee bending by applying pressure to their knees. Subsequently, they were prompted to extend their fingertips to the furthest point attainable and sustain this position for two seconds. The test was repeated thrice, and the average of the measurements in centimeters was documented (16,17).

Balance

To evaluate the functional balance of participants, the "Functional Reach Test" was administered. This assessment commenced by instructing the individual to extend their arm directly forward, recording the achieved distance. Subsequently, participants were tasked with reaching as far forward as possible without lifting their heels off the ground. The maximum distance attainable without compromising balance was marked. This process was reiterated thrice, and the average measurement was computed (18-20).

Functional Strength of Core Muscles

Functional strength of core muscles was evaluated with 'sit-ups and modified push-ups' tests (21,22).

Sit-ups Test: Individuals were asked to perform trunk flexion with knees in flexion position and feet in the position determined by the physiotherapist.

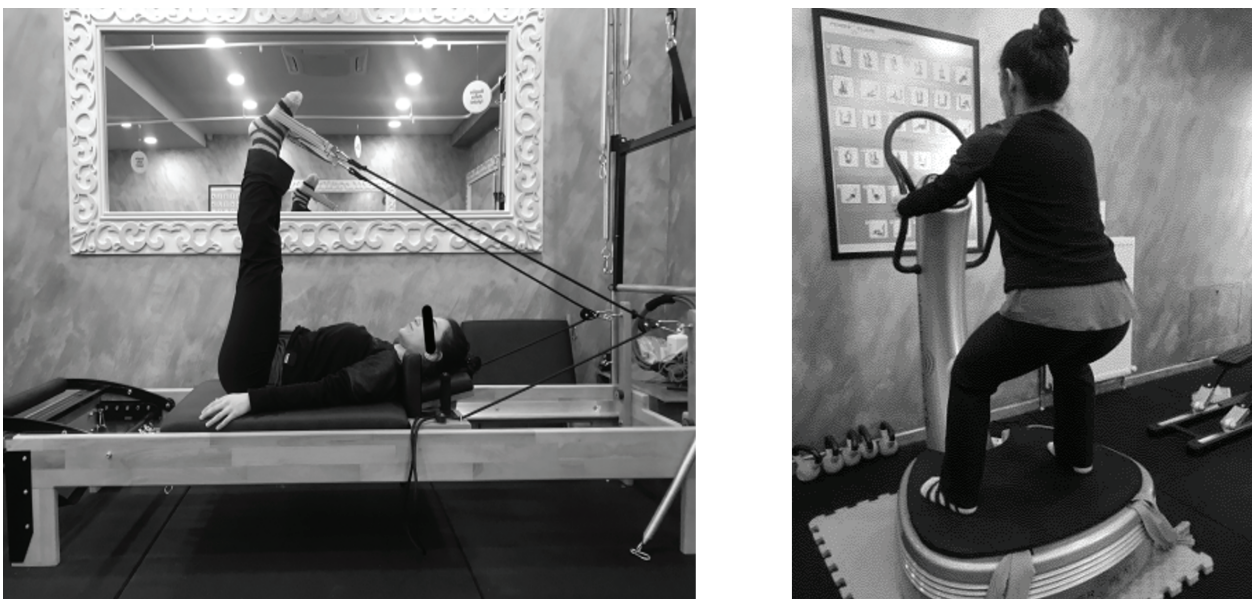

Figure 2. Pilates Exercise (Feet in Straps) and WBV Exercise (Squat) Examples

The number of movements that individuals could make for 30 seconds was recorded.

Modified Push-ups Test: Individuals were positioned in a prone position, hands at shoulder level, elbows flexed, next to the body. Individuals were asked to lift their head, shoulders and trunk off the ground with the elbows in full extension. During the test, the knees were positioned in flexion. The number of movements that individuals could make for 30 seconds was recorded.

Intervention

The implementation of Pilates and WBV exercises training was conducted by a trained physiotherapist (Figure 2). Before each session, participants in both training groups engaged in a series of warm-up activities (with roll down, side stretch, toy soldier stretch and saw), encompassing a single set of 10 repetitions and 10 minutes of stretching exercises targeting major muscle group throughout the body. Subsequently, cool-down exercises (static hip adductor muscle group stretching, hip flexor stretching, hamstring stretching, trunk lateral flexors stretching) were administered for 10 minutes at the session's conclusion. To maintain consistency, individuals within each group were advised not to partake in any additional training or dietary programs without informing the therapist.

Pilates Training: Clinical Pilates training was administered to the first group employing the "Reformer®" device for eight weeks, comprising two non-consecutive days per week, with each session lasting 45 minutes. The initial session encompassed an explanation of postural awareness and the fundamental principles of the Pilates method. The physiotherapist provided primary demonstrations of the exercises, accompanied by visual imagery. Over the course of training, participants were encouraged to focus on Pilates' foundational principles. The physiotherapist meticulously monitored and adjusted the exercises, offering tactile and verbal cues for corrections.

In subsequent weeks, starting with a single set of 10 repetitions, gradual adjustments were made with increases in the exercise position, spring resistance (yellow, green, blue and red) and the number of sets and repetitions, in which the individual stated that she did not have difficulty in the sets and number of sets. The exercise repertoire included activities such as foot work, tendon stretch, bridge, supine arm work, and long and short box series (4,23).

WBV Exercises Training: The second group participated in WBV exercises training utilizing the "Power Plate® pro5™ (71-PR5-3100-Performance Health Systems, LLC)" device for eight weeks, twice weekly on non-consecutive days, and each session lasting 40 minutes. This training entailed standing on the platform of the device. Initial exercises involved becoming accustomed to the vibrations, followed by a series of upper and lower extremity activities. These exercises encompassed various movements like lunges, squats, calf raises, and planks targeting different extremities. Studies have shown that high frequency vibration increases the activities of the lower extremity muscles more, so high frequency was used in the lower extremities (24,25). Training frequencies of 35 Hz for upper extremities and 50 Hz for lower extremities, alongside an amplitude of 3 mm, were employed. The training protocol evolved over the weeks, beginning with 30-second exercise sets for the first 1-3 weeks, extending to 45 seconds for weeks 4-6, and ultimately reaching 60 seconds for weeks 6-8, with the specific number of sets tailored to each individual. When individuals expressed that they did not feel fatigued when performing exercises and could tolerate longer durations, the duration of the exercise was increased. A 30-second inter-set break was observed (26).

Control Group: No specific training was provided to the control group. These participants were advised not to partake in any exercise or diet programs without informing the therapist and were encouraged to continue their regular daily activities. At the end of the study, individuals in the control group were included in the other groups they wished to participate in.

Statistical Analysis

The statistical package for social sciences (SPSS) version 20.0 was employed for the statistical analyses of this study (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp.). The concordance of the variables with normal distribution was analyzed be means of the Shapiro-Wilk test. For variables de-

Table 1. Physical and Sociodemographic Characteristics of Individuals.

	Pilates Group (n=12)	WBV Group (n=12)	Control Group (n=12)	p
Age (years), X±SD	34.16 ± 8.83	33.25 ± 8.13	28.08 ± 6.00	0.050
Body weight (kg), X±SD	62.41 ± 8.66	65.98 ± 7.16	63.30 ± 12.03	0.200
BMI (kg/m²), X±SD	23.88 ± 4.40	24.67 ± 2.79	23.44 ± 4.14	0.200
Educational Status, n (%)				
Postgraduate	1 (8.3)	2 (16.7)	0 (0)	**0.001**
University	8 (66.7)	6 (50)	8 (66.7)	
High school	3 (25)	4 (33.3)	3 (25)	
Primary education	0 (0)	0 (0)	1 (8.3)	
Profession, n (%)				
Working	5 (41.7)	5 (41.7)	8 (66.7)	**0.000**
Housewife	4 (33.3)	4 (33.3)	0 (0)	
Not working	3 (25)	3 (25)	4 (33.3)	

* p <0.05, p Statistical significance value of comparison between groups (Kruskal Wallis Test), X: Average, SD: Standard Deviation, n: Number, %: Percent, kg: Kilogram, m²: Square meter, WBV: Whole Body Vibration, BMI: Body Mass Index.

termined by measuring, average ± standard deviation (X ± SD) was calculated, whereas percentage (%) values were calculated for values determined by counting. Wilcoxon test was used to compare the pre- and post-training values of the groups. Kruskal Wallis test was used to compare the three groups. Mann-Whitney U Test was used to compare the groups two by two. The significance value was accepted to be p<0.05, whereas the level of significance used for triple testing was p<0.017 for Bonferroni correction purposes. The effect size (ES) was calculated according to the formula "r=z/√N" using the Z score of the Wilcoxon test (27). An ES value of 0.1-0.3 was accepted as "low", whereas 0.3-0.5 and >0.5 were accepted as "moderate" and "high", respectively (28).

RESULTS

Descriptive characteristics of the study participants are presented in Table 1. Notably, all descriptive features of the individuals were largely consistent, barring disparities in educational background and occupation, where no statistically significant differences were observed (p> 0.05). Examination of body composition data before and after training revealed no significant differences within any

Table 2. Comparison of Findings Related to Body Composition.

	Pilates Group (n=12) (X±SD)			WBV Group (n=12) (X±SD)			Control Group (n=12) (X±SD)			p²
	BT	AT	p¹	BT	AT	p¹	BT	AT	p¹	
BMI (kg/m²)	23.88±4.40	23.52±4.03	0.530	24.67±2.79	24.07±2.65	**0.010***	23.44±4.14	23.70±4.24	0.270	0.970
ES	0.120			0.520			0.220			
Waist-Hip Ratio (cm)	0.74±0.04	0.73±0.04	0.720	0.73±0.04	0.73±0.05	0.870	0.73±0.05	0.73±0.05	1.000	0.990
ES	0.070			0.030			0.000			
Muscle Weight (kg)	41.88±3.28	41.59±3.19	0.420	42.81±2.05	42.36±2.14	**0.040***	42.35±4.23	42.45±4.61	093.	0.810
ES	0.160			0.410			0.010			
Fat weight (kg)	18.50±6.44	17.63±5.45	0.230	20.91±5.55	19.78±5.68	**0.010***	18.69±8.48	19.41±8.22	0.130	0.490
ES	0.240			0,510			0,300			
Fat Percentage (%)	28.80±7.49	28.17±6.32	0.280	31.18±5.68	30.11±6.36	**0.030***	28.26±8.28	29.15±7.48	0.350	0.630
ES	0.210			0.420			0.190			
Lean Mass (kg)	43.85±3.28	43.55±3.11	0.450	45.00±2.31	44.67±2.11	0.190	44.59±4.42	44.66±4.82	0.960	0.680
ES	0.150			0.260			0.000			

* p <0.05, p¹ Within-group statistical comparison (Wilcoxon test), p² Statistical significance value of comparison between groups (Kruskal Wallis Test), X: Average, SD: Standard Deviation, WBV: Whole Body Vibration, BMI: Body Mass Index, kg: Kilogram, m2: Square meter, cm: Centimeter, n: Number, %: Percentage, BT: Before Training, AT: After Training, ES: Effect Size.

Tablo 3. Comparison of the Findings on Flexibility Balance and Functional Strength of Core Muscle.

	Pilates Group (n=12) (X±SD)			WBV Group (n=12) (X±SD)			Control Group (n=12) (X±SD)			p²
	BT	AT	p¹	BT	AT	p¹	BT	AT	p¹	
Sit and Reach Test (cm)	-10.75 94.8±	3.08 90.2±	**0.001**	-5.08 60.4±	1.66 83.2±	**≤0.010***	-5.33 89.6±	-3.50 16.5±	0.194	**≤0.010***
ES	0.620			0.620			0.260			
Functional reach test (cm)	34.00 15.5±	44.08 08.3±	**≤0.010***	36.08 23.3±	44.91 12.5±	**≤0.010***	37.16 32.4±	41.16 37.5±	**≤0.010***	0.130
ES	0,620			0,620			0,580			
"Sit-ups" test (The number of repetitions)	5.25±3.16	10.75±2.63	**≤0.010***	8.08±4.85	12.08±2.93	**0.020***	8.66±3.93	9.41±3.17	0.260	0.110
ES	0.620			0.580			0.400			
Modified "push-ups" test (The number of repetitions)	1.75±2.70	8.66±2.05	**≤0.010***	3.66±3.49	8.25±2.00	**0.020***	6.58±4.87	7.08±4.46	0.430	0.390
ES	0.620			0.610			0.240			

*p<0.05, p¹ Intra-group statistical comparison (Wilcoxon test), p² statistical significance value of comparison between groups (Kruskal Wallis Test), X: Mean, SD: Standard Deviation, WBV: Whole Body Vibration, BT: Pre-Training, AT: Post-Training, n: Number, cm: Centimeters, ES: Effect Size.

group (p> 0.05). Analysis of body composition findings across the study groups similarly indicated no discernible distinctions (p> 0.05). In terms of effect size analysis per group: Body composition findings in the Pilates group exhibited effect sizes ranging between 0.07 and 0.24, characterized as low. In the WBV exercises group, waist-hip ratio and lean mass demonstrated low effect sizes, while muscle weight and fat percentage displayed moderate effect sizes, and BMI and fat weight manifested high effect sizes. Body composition findings are detailed in Table 2.

Comparisons of participants' flexibility values are provided in Table 3. A statistically significant difference in flexibility was evident among all three groups (p≤0.01). In intra-group comparisons, significant differences were identified in the Sit-Reach Test results before and after training in both Pilates and WBV exercises groups (p≤0.01). Conversely, no statistically significant discrepancy was observed in the Sit-Reach Test outcomes pre- and post-training within the control group (p>0.05). Considering effect size analysis: Pilates and WBV exercises groups exhibited high effect sizes.

The control group demonstrated low effect sizes. Pairwise comparisons of flexibility findings are detailed in Table 4. No statistically significant distinctions emerged between the Pilates and WBV groups in these paired comparisons (p>0.017). However, significant differences were noted between the Pilates and control groups, as well as between the WBV and control groups, in the Sit-Reach Test (p<0.017).

No statistically significant differences in balance were discerned across all three groups (p>0.05). In intra-group assessments, a significant discrepancy was apparent in all groups' balance scores before and after training (p<0.05). Effect size analysis revealed high effect sizes for balance outcomes within all three groups. Pairwise comparisons of balance findings where no statistically significant

Table 4. Comparisons of Individuals' Findings on Flexibility, Balance and Functional Strength of Core Muscle in Pairs.

	Pilates Group-WBV Group	Pilates Group-Control Group	WBV Group-Control Group
	p³	p³	p³
Sit and Reach Test (cm)	0.267	**≤0.010***	**0.010***
Functional reach test (cm)	0.930	0.110	0.050
"Sit-ups" test (THE number of repetitions)	0.130	0.430	0.050
Modified "push-ups" test (THE number of repetitions)	0.810	0.180	0.320

p³ Pair comparison (Mann-Whitney U Test), *p<0.017 (Bonferroni Correction), WBV: Whole Body Vibration, cm: Centimeters.

differences were observed in paired group comparisons (p>0.017). When the findings regarding the strength of the core muscles of the study participants were examined, no statistical difference was observed between the three groups in the sit-ups and modified push-ups tests in the pre- and post-training evaluations (p>0.05). In intra-group comparisons, there was a significant difference in the findings regarding the strength of the core muscles in the Pilates and WBV groups in the pre- and post-training evaluations (p <0.05); There was no significant difference in the findings regarding the strength of the core muscles in the control group (p>0.05).

DISCUSSION

In our investigation, an 8-week Pilates training demonstrated no noteworthy influence on body composition. Conversely, the application of WBV exhibited the capacity to decrease body fat weight and fat percentage. Notably, body composition remained relatively unchanged within the control group. Turning to the realm of flexibility, a substantial distinction was detected across all groups. Although both the Pilates and WBV groups displayed significant variations in comparison to the control group, no significant differentiation emerged between the Pilates and WBV groups. Evaluation of individuals' balance outcomes yielded no significant variations in terms of balance within all three groups. Intriguingly, significant differences were revealed in intragroup assessments for all groups both before and after training. When looking at the functional strength of the core muscles, in intra-group comparisons, there was a significant difference in the findings regarding the strength of the core muscles in the Pilates and WBV groups in the pre- and post-training evaluations.

Body composition stands as one of the vital health indicators, and excessive body weight and fat pose a common and substantial health concern. At the study's outset, the participants exhibited BMI values spanning from normal to overweight. Post-training, there were no BMI changes in the Pilates and control groups. Conversely, a reduction in BMI was observed in the WBV group. However, this decrease wasn't significant compared to the other groups. Initially, the waist-to-hip ratios of the subjects were within the normal range. Post-training, no alteration in waist-to-hip ratio was observed in any group.

Ideally, the recommended body fat ratio for women is around 25% (29). Initially, body fat ratios ranged from normal to risky levels. Upon analyzing the BEA (Body Electrical Analyzer) results, a minor decrease in muscle weight, fat percentage, and fat weight was noted in the WBV group. Nevertheless, this change wasn't statistically significant when compared to the pilates or control group. Based on these outcomes, the eight-week pilates exercise regimen did not yield significant effects on body composition. Although changes were observed in the WBV group, these changes did not exhibit superiority over the other groups.

Particularly, alterations in BMI values stemmed from both the modest increase in muscle mass and the notable reduction in fat mass. While a substantial body weight transformation was not anticipated in our study, shifts in muscle and fat ratios were expected.

Literature contains studies both supporting and refuting the effectiveness of pilates and WBV training on body composition. For instance, Jago et al. (30) conducted a study involving 30 young girls aged 11 years, where pilates training was administered five days a week for four weeks, demonstrating the effectiveness of pilates exercises in reducing BMI. However, we think that the fact that this study consists of 11-year-old teenage girls may affect the results of the study. Similarly, a study revealed positive effects of pilates training using the 'Reformer®' apparatus on body composition among healthy women (31). We also believe that the duration of this study being conducted over 16 weeks may have influenced the effect of pilates on body composition in long-term training. A systematic review on the effects of the pilates method has also reported that to change anthropometric variables and body composition, two to four sessions per week for eight weeks or longer are necessary (32). In investigations akin to our own, Şavkın and Aslan found that an eight-week pilates training regimen improved body composition values assessed via hip circumference measurements and BEA (23). A review published in 2015 on WBV highlighted its

effectiveness on body composition (33). However, Segal et al., in their study involving 32 healthy adults, reported no changes in body composition assessed via BEA after administering pilates training (34,35) . Likewise, Rubio-Arias et al. noted that their three-day-a-week, six-week WBV training in healthy individuals did not impact body composition (35,36).

Zago et al. concluded that altering body composition in obese patients necessitated a minimum of 10 weeks of WBV training (37). On the other hand, Sekendiz et al. recommended a comprehensive approach involving proper training, sustained follow-up studies, and a well-balanced dietary program to effectively reduce weight and fat percentage (38).

Flexibility constitutes a vital component of physical fitness, often evaluated through various methods, with the Sit-Reach Test being the most common measurement. In our study, the Sit-Reach Test was utilized to assess flexibility. Initial values of the participants were notably low. Upon completion of the training, it became evident that both pilates and WBV led to a similar improvement in flexibility. This enhancement aligns with the anticipated outcome in accordance with the fundamental goals and principles of pilates exercises (39).

Meanwhile, the impact of WBV training on flexibility can be attributed to neural circulation and thermoregulatory factors. In stretching exercises, the pain threshold acts as a natural limit. Vibration application, however, elevates this threshold, allowing for more effective stretching. The application of WBV to muscles induces a significant analgesic effect during and post-application. Another possible mechanism involves muscle relaxation followed by the inhibition of contraction due to the excitation of the Golgi tendon organ (40,41). Abundant evidence supports the effectiveness of pilates and WBV on flexibility, which is congruent with the findings of our study.

Balance encompasses a multifaceted process involving sensory, motor, and cognitive elements. The central nervous system combines somatosensory, visual, and vestibular inputs to determine body position, posture, and motor responses. Skill in maintaining balance is pivotal during movement or static positions and significantly influences the development of other motor systems. Our study revealed an increase in balance across all three groups, with no discernible inter-group differences. The anticipated elevation in balance within the pilates and WBV groups aligns with expectations. However, the unanticipated enhancement in the control group's balance could be linked to a learning effect associated with the test.

Contradictory findings exist within the literature. Johnson et al., exploring the effects of "reformer" pilates training on balance in healthy adults, concluded that a 5-week, 2-days-a-week training regimen improved balance in 17 individuals (42). Kloubec's research, investigating the effects of 12-week, 2-days-a-week mat pilates training on muscular endurance, flexibility, balance, and posture in 50 healthy individuals, revealed enhanced muscle endurance and flexibility due to pilates exercises. While balance and posture improvements were not significant compared to the control group (43). Research exploring WBV's impact on balance generally involves elderly individuals and those with neurological conditions. Ebersbach et al. found that WBV application improved balance and gait but was not superior to conventional exercises (44).

In our literature review, we could not find any study evaluating the effect of WBV on the core muscles. The reason for this is that the strengthening effect of WBV is thought to be directly on the extremity muscles. In our study, although intra-group values in functional core strength were positively affected, it was observed that this increase was not different from the control group. Tolnai and colleagues found that 10 weeks of pilates training once a week in healthy young women was effective on endurance assessed by plank test and strength assessed by sit ups test (39).

The results of the study found that both pilates exercises and WBV training improved flexibility, balance, and functional strength of core muscles. Additionally, WBV training led to a decrease in BMI and BIA parameters. Based on the findings of this study, if an individual's primary goal includes reducing body composition, they should prefer WBV training. While pilates training improves flexibility, balance, and functional strength of core muscles,

when performed alone, it does not significantly alter body composition parameters.

Our study had some limitations. The first limitation of our study is that single or double blindness could not be achieved. Another limitation was that individuals' daily work and activity factors were not controlled. At the beginning of the study, all individuals were asked not to participate in any other exercise or diet program. But occupational factors, housework and leisure activities were not limited. Pilates and WBV are trainings that involve the whole body. In terms of muscle strength, not only core functional strength but also lower and upper extremity strengths could be evaluated objectively.

As a result, it was found that Clinical pilates and WBV exercises trainings applied two days a week for eight weeks had the same positive effects on flexibility.

It was observed that both trainings can be used safely, except for simple side effects such as headache (in WBV) and delayed onset muscle soreness. Pilates and WBV exercises trainings are applied to both healthy and patient populations, and their use in clinics is becoming increasingly common. Different application methods or parameters have been used in studies in literature. For this reason, the results of the studies vary. However, there are very few studies comparing both training methods. We think that there is a need for research comparing pilates and WBV exercises training and that our study will guide other studies on this subject.

In accordance with the findings of our study, significant intragroup differences were identified within the WBV group concerning BMI, muscle weight, fat weight, and fat percentage. Conversely, in all other groups, no significant disparities were observed in terms of body composition data, and there was no discernible distinction between the three groups. Notably, significant differences emerged among all three groups concerning flexibility, while no statistically significant variation was detected in terms of balance within the groups. Intriguingly, intragroup comparisons yielded statistically significant differences for all groups both before and after training.

WBV and pilates training are applied across both healthy and patient populations, and their clinical application is on the rise. Variation in application methods and parameters among studies in the literature leads to differing outcomes. Consequently, there is a scarcity of studies comparing both training methods. We propose that further investigations comparing pilates and WBV training are warranted, and we believe our study will provide guidance for future research in this domain.

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ADÖLESAN KADIN BASKETBOLCULARDA KOR STABİLİTE İLE DENGE VE ALT EKSTREMİTE PATLAYICI GÜCÜ ARASINDAKİ İLİŞKİSİNİN İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın primer amacı, adölesan kadın basketbolcularda kor stabilitesinin bir bileşeni olan kor dayanıklılığın, denge ve alt ekstremite patlayıcı gücü arasındaki ilişkiyi incelemektir. Çalışmanın sekonder amacı ise, basketbol oynayan ve oynamayan adölesanlar arasında kor endurans, denge ve patlayıcı güç açısından karşılaştırma yapmaktır.

Yöntem: Bu çalışmanın tasarımı kesitsel tanımlayıcı tiptedir. Çalışmaya 10 ile 15 yaş arasında olan 112 kadın basketbolcu dahil edildi. Katılımcılar basketbol oynayan çalışma grubu (n=56) ve basketbol oynamayan kontrol grubu (n=56) olmak üzere iki gruba ayrıldı. Her iki gruptaki katılımcılar gövde fleksiyonu, gövde ekstansiyonu, yan plank ve yüzükoyun köprü testleri kullanılarak kor stabilitesi, Y denge testi kullanılarak denge ve durarak uzun atlama testi kullanılarak alt ekstremite patlayıcı gücü açısından değerlendirildi. Bütün değerlendirmeler 3 defa yapıldı ve ortalaması alındı.

Sonuçlar: Çalışma grubunun grup içi değerlerinde; durarak uzun atlama testi ile sağ-sol ekstremitede Y denge testinin tüm yönlerinde ve gövde fleksör testi arasında ayrıca denge ve kor stabilite testleri arasında anlamlı bir ilişki bulunmadı (p>0,05). Durarak uzun atlama testi ile gövde ekstansör (p<0,001), sağ lateral köprü (p=0,001), sol lateral köprü (p<0,001), köprü (p=0,022) testleri arasında çok yüksek düzeyde anlamlı bir ilişki bulundu. Çalışma grubunun kontrol grubuna göre gövde ekstansör testi hariç (p=0,62), kor endurans testlerindeki duruş süresi, denge ve sıçrama mesafeleri istatistiksel olarak daha iyi sonuçlar verdi (p<0,001).

Tartışma: Adölesan kadın basketbolcularda, dengenin, endurans ve alt ekstremite patlayıcı gücü ile ilişkili olmadığı, ancak kor endurans ile alt ekstremite patlayıcı gücü arasında anlamlı bir ilişki olduğu gösterildi. Adölesan kadın basketbolcuların basketbol oynamayan kadınlara göre denge, patlayıcı güç ve kor stabilite açısından daha iyi olduğu görüldü.

Anahtar kelimeler: Adölesan, basketbol, fiziksel dayanıklılık, kas kuvveti, postüral denge

INVESTIGATION OF THE RELATIONSHIP BETWEEN CORE STABILITY AND BALANCE AND LOWER EXTREMITY POWER IN ADOLESCENT FEMALE BASKETBALL PLAYERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The primary aim of the study is to examine the relationship between core endurance, a component of core stability, and the balance and explosive power of the lower extremity in adolescent female basketball players. The secondary aim of the study was to make a comparison between basketball playing and non-playing adolescents in terms of core endurance, balance and explosive power.

Methods: The design of this study was cross-sectional descriptive. 112 female individuals between the ages of 10y and 15y were included in the study. Participants were divided into two groups: the study group (n=56) playing basketball and the control group (n=56) not playing basketball. Participants in both groups were assessed for core stability using trunk flexion, trunk extension, side plank, and prone bridge tests, balance using the Y balance test, and lower extremity explosive power using the standing long jump test.

Results: In the in-group values of the study group; there was no significant relationship between the standing long jump test and all aspects of the right-left extremity Y balance test and trunk flexor test, and between the balance and core stability tests (p>0.05). A highly significant relationship was found between the standing long jump test and trunk extensor (p<0.001), right lateral bridge (p=0.001), left lateral bridge (p<0.001), and bridge (p=0.022) tests. It was observed that the study group gave significant results in all evaluations (p<0.001) compared to the control group, except for the trunk extensor test (p=0.62).

Conclusion: It was shown that balance was not related to endurance and lower extremity power, but there was a significant relationship between core endurance and lower extremity power in adolescent female basketball players. Adolescent female basketball players had better balance, explosive power and core stability than non-basketball players.

Key Words: Adolescent, basketball, muscular strength, physical endurance, postural balance

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GİRİŞ

Basketbol sporu dünya genelinde pek çok ülkede en popüler sportif aktivitelerden biridir (1). Basketbol için gerekli olan beceriler komplekstir; sporcunun iyi bir aerobik kapasiteye, anaerobik güce, hıza, çevikliğe, dengeye ve kuvvete sahip olması gerekir (1,2). Basketbol, oyun içerisinde vücut pozisyonunda birçok değişiklik gerektiren bir spor dalıdır. Basketbolu, diğer spor dallarından ayıran önemli bir özellik, hareketlerin çoğunun vertikal ve frontal düzlemlerde gerçekleştirilmesidir (3). Tüm bu gerekliliklerin sağlanması için basketbola özgü hareketler sırasında gücün verimli bir şekilde oluşturulması, gövde stabilizasyonunun sağlanması ve dengenin korunması oldukça önemlidir (1,3).

Kor bölgesi;, omurga, pelvis ve abdomenin yumuşak ve kemik doku yapılarını içeren, omurga ve gövdedeki pek çok farklı kasa yapışma yeri sağlayan ve vücudun merkezi olarak kabul edilen bir bölgedir (3-9). Kor, vücut içindeki kuvvetler üzerinde bir kontrol sistemi gibi işlev görmektedir. Bu talep sadece yeterli miktarda kuvvete bağlı değil, aynı zamanda hassas kontrol ve zamanlama da gerektirir (8). Kor kasları, gövdenin stabilizasyonunu sağlayarak alt ekstremite hareketlerinin güvenli ve kontrollü bir şekilde gerçekleşmesini sağlar. Kor stabilite genel olarak kuvvet ve hareketin optimal üretimi, kontrolü ve kuvvet transferine izin veren, lumbopelvik dinamik kontrolün temel yapısı olarak tanımlanır (4-7). Basketbolun çok yönlü doğası, sporcuları her 2-3 saniyede bir yön veya pozisyon değiştirmeye zorlayan sürekli hızlanma ve yavaşlama gerektirir. Oyun esnasında spora özgü bu gerekliliklerin karşılanabilmesi, güçlü bir kor bölgesi ile mümkün olacaktır (3,9).

Basketbol oyuncuları, oyun esnasında hızlanma, yavaşlama ve yön değişikliği gibi yüksek yoğunluklu aktiviteler gerçekleştirmektedir. Bu hareketler özellikle alt ekstremite gücü ile ilişkilidir ve spor performansı için önemlidir. Bu nedenle, bu spor dalına özgü temel hareketleri başarıyla yapabilmek için güç ve denge gibi özelliklerin değerlendirilmesi ve geliştirilmesi büyük önem taşımaktadır (8,9). Basketbol, dinamik yapısı gereği sürekli değişen hareketler içerir ve bu da basketbolcular için güç değerlendirmesini gereklilik haline getirmektedir (9).

Basketbol, temas sporu olarak kabul edilmese de oyun sırasındaki teknik hareketler ve yoğun fiziksel etkileşimler basketbolcuları tekrarlı fiziksel streslere maruz bırakmaktadır (1). Bu nedenle basketbol sporunda en sık yaralanma görülen vücut bölümü alt ekstremitedir ve yaralanma riskinin özellikle adölesan basketbolcularda arttığı gösterilmektedir (1,10). Cinsiyetler kıyaslandığında ise adölesan kadın basketbolcuların erkek basketbolculara göre daha sık yaralandığı bulunmuştur (10).

Vücut hareketleri sırasında, kor kasları ile alt ekstremite hareketleri arasında sinerjik bir etkileşim olduğu gösterilmektedir (11). Korun, vücuttaki sistemlerle ve alt ekstremite ile olan ilişkisi ve gövdedeki konumu nedeniyle, basketbolda sportif performansta önemli olan denge ve patlayıcı güç (1,2) gibi komponentler ile ilişkili olabileceği düşünülmektedir. Bu hipotezin doğruluğu gösterilirse, basketbol sporunda yaralanma risk faktörleri arasında bulunan ve sportif performans için önemli olan denge ve alt ekstremite patlayıcı gücünü geliştirmek için, kor stabiliteyi içeren yeni antrenman stratejileri geliştirilebilir.

Kor kuvveti, kor propriosepsiyonu ve korun nöromusküler kontrolündeki eksiklik veya yetersizlikler, alt ekstremite yaralanmalarının gelişiminde risk faktörleridir ancak kor enduransı ile sportif veya fonksiyonla ilgili parametreler arasındaki ilişkiyi değerlendiren çalışmalar ve kor enduransının alt ekstremite yaralanmaları için risk faktörü olması konusundaki kanıtlar çelişkilidir (4,11). Bununla birlikte, literatür araştırmalarımıza göre, kadın adölesan basketbolcularda kor enduransı ile denge ve alt ekstremite gücü arasındaki ilişkiyi inceleyen daha önce yapılmış herhangi bir çalışmaya rastlanmamıştır.

Çalışmanın primer amacı kadın adölesan basketbolcularda yaralanmaların önlenmesinde ve performansın artırılmasında önemli kor endurans ile alt ekstremite patlayıcı gücü ve denge arasındaki ilişkinin incelenerek ortaya konmasıdır. Çalışmanın sekonder amacı basketbol oynayan ve oynamayan adölesanlar arasında kor endurans, denge ve patlayıcı güç açısından karşılaştırma yapmaktır.

Çalışmanın hipotezleri şu şekildedir:

H1: Adölesan kadın basketbolcularda kor stabilite ile denge ve alt ekstremite patlayıcı gücü arasında ilişki yoktur.

H2: Basketbol oynayan ve oynamayan kadın adölesanlar arasında kor stabilite ile denge ve alt ekstremite patlayıcı gücü arasında fark yoktur.

YÖNTEM

Bu çalışmanın tasarımı kesitsel tanımlayıcı tiptedir.

Örneklem ve Katılımcılar

Çalışma için yaş aralığı 10-15 yıl olan toplam 114 adölesan kadın birey değerlendirildi. İki kişi dahil edilmeme kriterlerinden kronik rahatsızlık varlığı nedeni ile dışlanmıştır. Çalışmaya gönüllü olan 112 katılımcı araştırmacılar tarafından, çalışma (n=56) ve kontrol (n=56) grubu olmak üzere iki gruba ayrıldı. Çalışma grubu basketbol takımında oynayan adölesan kadın basketbolculardan, kontrol grubu ise herhangi bir sportif katılımı olmayan adölesan kadınlardan oluşmaktadır. Çalışmaya katılan adölesan basketbolcular haftada minimum 2 kere ortalama 4 saat antrenman yapmaktadırlar. Çalışma katılımcılarına Gaziantep ilindeki Yükselen Yıldızlar Spor Kulübü'nden ve kontrol grubu katılımcılarına ise Gaziantep Seçkin Koleji'nden ulaşılmıştır.

Çalışma SANKO Üniversitesi Fizyoterapi ve Rehabilitasyon Bölümü Ölçme ve Değerlendirme Laboratuvarı'nda Ağustos 2021- Ekim 2021 tarihleri arasında gerçekleştirildi. Çalışmaya başlamadan önce SANKO Üniversitesi Girişimsel Olmayan Etik Kurulu'ndan onay alındı (2021/07). Bütün katılımcılara çalışma öncesinde bilgi verilerek, çalışmaya katılan katılımcılara ve ailelerine bilgilendirilmiş gönüllü olur formu imzalatıldı. Çalışma Helsinki Deklerasyonu Prensipleri'ne uygun olarak yapıldı.

Çalışmaya dahil edilme kriterleri katılımcıların adölesan yaş grubunda ve kadın cinsiyette olması, basketbolu sportif aktivite olarak yapıyor olması, cerrahi geçmişinin ve tanı almış kronik bir rahatsızlığının olmamasıdır. Kontrol grubunun çalışmaya dahil edilme kriterleri ise katılımcıların adölesan yaş grubunda, kadın cinsiyette olması, herhangi bir sportif aktivite yapmıyor olması, cerrahi geçmişinin ve tanı almış kronik bir rahatsızlığının olmamasıdır.

Değerlendirme Yöntemleri

Katılımcıların sosyodemografik (yaş, boy, vücut ağırlığı gibi) özellikleri ve klinik özellikleri (kronik hastalık varlığı, düzenli ilaç kullanımları, geçirilmiş cerrahi varlığı) kaydedildi. Katılımcıların ayrıca dominant alt ekstremitesi, "Topa hangi bacak ile vurmayı tercih edersiniz?" sorusu yöneltilerek, sorgulandı. Katılımcının topa vurmayı tercih ettiği bacak tarafı dominant alt ekstremite olarak kabul edildi (12). Performans testlerini etkileyebileceğinden dolayı menstrüasyon dönemi sorgulanarak, değerlendirmeler katılımcıların menstrüasyon dönemi dışında yapıldı.

Fiziksel değerlendirme kapsamında; denge, patlayıcı güç ve kor endurans değerlendirmeleri yapıldı. Tüm testlerden önce katılımcıların teste alışması için deneme yapmalarına izin verildi. Testlerden önce 5 dakika süre ile büyük kas gruplarına yönelik ısınma protokolü uygulandı. Değerlendirmeler, tüm katılımcılara aynı fizyoterapist tarafından yaptırıldı. Isınmalar sonrasında bütün değerlendirmeler aynı sıra ile yapıldı. Önce kor endüransı değerlendirmesi, daha sonra denge değerlendirmeleri, en son ise alt ekstremite patlayıcı güç değerlendirmesi yapıldı. Bütün değerlendirmeler 3 defa yapıldı ve ortalaması alındı.

Kor Endurans Değerlendirmesi

Kor kaslarının endüransını değerlendirmek için Mcgill kor stabilite testleri ve yüzükoyun köprü testi kullanıldı (13,14). Mcgill kor stabilite testleri; kor endüransını 3 farklı pozisyonda ölçen üç testi içermektedir (gövde ekstansiyon testi, gövde fleksiyon testi, lateral köprü testi). Stabilite testleri sağlıklı popülasyonda orta-çok yüksek güvenirliğe sahip ölçümlerdir (13,14).

Gövde Ekstansiyon Testi: Katılımcılar test için bir sedye üzerinde yüzüstü pozisyonlandı. Katılımcının pelvisi, kalça ve dizleri sedye üzerinde sabitlenirken, gövde ve üst ekstremiteleri sedyenin dışarısında kalacak şekilde sedye ile aynı boyda bir sandalye yardımı ile sabitlendi. Test sırasında sandalye desteği kaldırılarak kollar göğüste çaprazlanarak gövdesini horizontal bir şekilde tutması istendi. Bireyin pozisyonunu koruduğu süre saniye (sn) cinsinden kaydedildi (13,14).

Gövde Fleksiyon Testi: Katılımcılar test için gövde 60o fleksiyonda, dizler ve kalça 90o fleksiyonda pozisyonlandı. Katılımcıdan, kolları göğsünde çapraz tutarak pozisyonu bozmadan kalması istendi. Bireyin pozisyonunu koruduğu süre sn cinsinden kayde-

dildi (13,14).

Lateral Köprü Testi: Katılımcılardan yan yatış pozisyonunda, üstteki bacak diğer bacağın önüne gelecek şekilde, vücudu düz tutarak, dirseklerden biri ile yerden destek alırken kalçasını yerden uzaklaştırarak bu pozisyonu bozmadan kalması istendi. Bireyin pozisyonunu koruduğu süre sn cinsinden kaydedildi (13,14).

Yüzükoyun Köprü Testi: Katılımcılardan yüzüstü, alt ekstremitesi yerde ve ekstansiyonda, ön kolları nötral pozisyonda olacak şekilde bilateral dirsek fleksiyonu yapması ve test başladığında gövdesini zeminden uzaklaştırarak dirsekler ve ayaklar üzerinde pozisyonunu koruması istendi. Bireyin pozisyonunu koruduğu süre sn cinsinden kaydedildi (14,15).

Denge Değerlendirmesi:

Çalışmada denge değerlendirmesi için Y Denge Testi kullanıldı. Y Denge Testi, Yıldız Denge Testi yerine geliştirilmiş bir testtir. Y Denge Testi için katılımcıdan, yere çizilen Y Denge Testinin üzerinde eller belde ve bir ayağı merkezde sabit bir şekilde durması istendi. Sonrasında test edilecek ekstremite ile dengesini koruyarak anterior, posteromedial ve posterolateral yönlere doğru parmak ucu ile dokundu. Uzanılan mesafeler santimetre (cm) cinsinden kaydedildi. Test her üç yönde ve her iki alt ekstremite için 3 kez tekrar edildi. Ölçümlerin ortalaması alınarak skorlaması hesaplandı (17). Ölçümlerin skorlaması "Uzanma mesafesi (cm)/bacak uzunluğu (cm) × 100 formülü ile hesaplandı.

Alt Ekstremite Patlayıcı Güç Değerlendirmesi

Alt ekstremitenin patlayıcı gücünü değerlendirmek için güvenilirliği gösterilmiş bir yöntem olan durarak uzun atlama testi kullanıldı. Durarak uzun atlama testi değerlendirmesi için katılımcılardan, yere önceden çizilen bir çizginin gerisinde durup adım almadan çömelip çift ayakla sıçrayabildiği kadar uzağa sıçraması istendi. Katılımcının sıçradığı noktadaki topuk mesafesi ile çizgi arasındaki mesafe cm cinsinden kaydedildi. Test katılımcılara üç defa tekrarlandı ve ortalama sonuç kaydedildi (16). Bu testin güvenirliği 0,70 – 0,94 olarak bildirilmiştir (18).

İstatistiksel Analiz

Örneklem hesabı G*power windows programı kullanılarak yapıldı. "Elite Female Basketball Players' Body-Weight Neuromuscular Training and Performance on the Y-Balance Test" başlıklı makalede iki basketbol takımından deney ve kontrol grubu olarak belirlenen sporcuların Y denge testi puanı dikkate alınarak, Alpha(α)=0,05 ve güç=0,80 olacak şekilde hesaplama yapıldığında minimum örneklem büyüklüğü grup başına 56 olarak bulundu (19). Verilerin analizi için IBM SPSS Statistics (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY: IBM Corp) paket programı kullanıldı. Tanımlayıcı istatistik olarak; ölçümle belirtilen sürekli değişkenler için ortalama ve standart sapma veya medyan ve minimum-maksimum değerleri, kategorik değişkenler için frekans ve yüzde değerleri verildi. Verilerin normal dağılımı Shaphiro-wilk testi ile test edildi. Kor stabilite, denge ve patlayıcı güç değerlendirme verileri normal dağılım göstermedi. Elde edilen veriler normal dağılım göstermediği için basketbol oynayan ve oynamayan sporcuların kor stabilite, denge ve patlayıcı güç değerlerinin istatiksel karşılaştırmasında parametrik olmayan Mann-Whitney U testi kullanıldı. Kor stabilite, denge ve patlayıcı güç arasındaki ilişkiler çalışma grubunun kendi içerisinde olacak şekilde Spearman's rho korelasyon testi kullanılarak yapıldı. Kategorik değişkenlerin grup karşılaştırmaları için

Tablo 1. Grupların Demografik Özellikleri

Değişkenler	Çalışma grubu (n=٥٦) X±SS		Kontrol grubu (n=56) X±SS	
Yaş	12,61±1,951		12,48±1,572	
VKİ, kg/m²	20,046±3,498		19,248±3,129	
Dominant ekstremite	Dominant Taraf		Dominant Taraf	
	Sağ N (%)	Sol N (%)	Sağ N (%)	Sol N (%)
	52 (%92,9)	4 (%7,1)	53 (%94,6)	3 (%5,4)

VKİ: Vücut kütle indeksi, Kg: Kilogram, m^2: Metre Kare.

ki-kare testi kullanıldı. İlişki analizi sadece çalışma grubuna yapıldı. Karşılaştırma analizi her 2 gruba da yapıldı. Kolerasyon katsayıları; 0- 0,29 "korelasyon yok", 0,30- 0,49 "zayıf", 0,50 - 0,69 "orta", 0,70 - 0,89 "yüksek" ve >0,90 "çok yüksek olarak hesaplandı (20).

BULGULAR

Araştırmaya katılan katılımcıların toplam yaş ortalaması 12,54 ±1,76 yıl, vücut kütle indeksi (VKİ) ortalaması 19,65±3,31 kg/m2 idi. Çalışmaya dahil edilen kişilerin demografik özellikleri arasında anlamlı bir farklılık bulunmadı (p>0,05) (Tablo 1). İlişki analizi sadece çalışma grubuna yapılmıştır. Karşılaştırma analizi her iki gruba da yapıldı.

Çalışmaya katılan katılımcıların dominant ekstremiteleri sorgulandığında, çalışma grubunun (%92,90; n=52) ve kontrol grubunun (%94,60; n=53) büyük çoğunluğunun (%93,80; n=105) sağ ekstremitesinin dominant olduğu kaydedildi (Tablo 1).

Çalışma grubu, Y denge testi ve kor stabilite testlerinin birbirleri olan ilişkileri açısından incelendiğinde iki parametre arasında istatistiksel olarak anlamlı bir ilişki bulunmadı (p>0,05) (Tablo 2).

Çalışma grubunda, kor stabilite ve patlayıcı güç arasındaki ilişki incelendiğinde: durarak uzun atlama testi; gövde ekstansör testi (p<0,001, r=0,461), sağ lateral köprü (p=0,001, r= 0,441), sol lateral köprü (p<0,001, r=0,465) ve köprü testi (p=0,022, r=0,305) testleri ile pozitif yönde, çok yüksek düzeyde ilişkili bulundu (Tablo 3). Durarak uzun atlama testi ve yüzüstü köprü testi (p=0,085, r=0,232) arasında anlamlı bir ilişki bulunmadı (Tablo 3).

Çalışma grubunda denge testi ve patlayıcı güç testinin grup içi ilişkilerine bakıldığında; durarak uzun atlama testi ile Y denge testinin tüm yönleri; sağ anterior (p=0,613, r=0,069), sağ posteromedial (p=0,621, r=0,067), sağ posterolateral (p=0,952, r=0,008), sol anterior (p=0,192, r=0,177), sol posteromedial (p=0,500, r=0,092), sol posterolateral (p=0,533, r=0,085) arasında anlamlı bir ilişki bulunmadı (Tablo 4).

Y denge testi açısından iki grup karşılaştırıldığında, sağ ve sol alt ekstremite için tüm yönlerde (anterior, posteromedial ve posterolateral) çalışma gru-

Tablo 2. Çalışma Grubunun Kor Stabilite Testleri ve Y Denge Testi Veri Sonuçları Arasındaki Grup İçi İlişkileri

	Sağ anterior (cm)		Sağ postero-medial (cm)		Sağ postero-lateral (cm)		Sol anterior (cm)		Sol postero-medial (cm)		Sol postero-lateral (cm)	
	r	p	r	p	r	p	r	p	r	p	r	p
Gövde Ekstansör Kas Testi (sn)	-0,076	0,577	0,012	0,931	-0,132	0,333	0,083	0,544	0,114	0,405	-0,014	0,921
Sağ Lateral Köprü Testi (**sn**)	-0,100	0,465	-0,146	0,283	-0,060	0,661	-0,111	0,416	0,068	**0,617****	-0,067	0,625
Sol Lateral Köprü Testi (**sn**)	-0,020**	0,882	-0,050	0,713	**0,051****	0,707	-0,052	0,706	0,127	0,351	0,010	0,942
Yüz Üstü köprü Testi (sn)	-0,094	0,491	-0,184	0,175	-0,081	0,553	-0,081	-0,105	0,440	**-0,055****	-0,122	0,370
Gövde fleksör testi Testi (sn)	0,078	0,568	-0,001	0,996	0,050	0,715	-0,011	0,935	**0,023****	0,868	-0,011	0,936

*: p≤0,001 düzeyinde istatistiksel anlamlılık, **: p≤0,05 düzeyinde istatistiksel anlamlılık, Cm: Santimetre, Sn: Saniye

Tablo 3. Çalışma Grubunun Kor Stabilite Test ve Patlayıcı Güç Değerlerinin Grup İçi İlişkileri

	Durarak uzun atlama testi (n=56) (cm)	
	r	p
Gövde ekstansör testi (sn)	0,461	**<0,001***
Sağ lateral köprü testi (**sn**)	0,441	**0,001***
Sol lateral köprü testi (**sn**)	0,465	**<0,001***
Köprü testi (sn)	0,305	**0,022****
Yüzüstü köprü testi (sn)	0,232	0,085

*: p≤0,001 düzeyinde istatistiksel anlamlılık, **: p≤0,05 düzeyinde istatistiksel anlamlılık, Sn: Saniye, Cm: Santimetre

Tablo 4. Çalışma Grubunun Denge ve Patlayıcı Güç Değerlerinin Grup İçi İlişkileri

Y denge testi (cm)	Durarak uzun atlama testi (n=56) (cm)	
	r	*p*
Sağ		
Anterior	0,069	0,613
Posteromedial	0,067	0,621
Posterolateral	0,008	0,952
Sol		
Anterior	0,177	0,192
Posteromedial	0,092	0,500
Posterolateral	0,085	0,533

*: p≤0,001 düzeyinde istatistiksel anlamlılık, **: p≤0,05 düzeyinde istatistiksel anlamlılık, Cm: Santimetre.

Tablo 5. Çalışma ve Kontrol Grubunun Kor Stabilite Testleri ve Y Denge Testi Veri Sonuçları Arasındaki Karşılaştırma

	Çalışma grubu (n=٥٦) X (min-maks)	Kontrol grubu (n=56) X (min-maks)	p
Gövde ekstansör testi	50 (34,50-86,50)	68 (45-93)	0,062
Sağ lateral köprü testi	36,65 (27-53)	16 (10-29)	**<0,001***
Sol lateral köprü testi	31,50 (22-50)	17 (10-24)	**<0,001***
Yüzüstü köprü testi	50,50 (35-70)	26 (18,50-40)	**<0,001***
Gövde fleksör testi	45,50 (30-67)	31 (22-54)	**0,033****
Durarak uzun atlama	131,50 (112,0-148,75)	111,50 (94-124)	**<0,001***
Y Denge testi yönleri			
Sağ anterior	131,37 (116,39-144,09)	90,62 (79,18-106,88)	**<0,001***
Sağ posteromedial	122,67 (110,66-132,55)	88,12 (76,50-101,15)	**<0,001***
Sağ posterolateral	136,04 (117,28-149,98)	89,81 (81,46-101,91)	**<0,001***
Sol anterior	122,63 (109,54-146,39)	95,75 (79,12-107,06)	**<0,001***
Sol posteriomedial	122,16 (110,43-139,33)	89,20 (81,48-100)	**<0,001***
Sol posterolateral	124,91 (106,62-143)	94,65 (82,96-109,05)	**<0,001***

*: p≤0,001 düzeyinde istatistiksel anlamlılık, **: p≤0,05 düzeyinde istatistiksel anlamlılık, Min: Minimum değer, Maks: Maksimum Değer

bunun kontrol grubuna göre denge testinde uzanma mesafeleri istatistiksel olarak daha yüksekti (p<0,001) (Tablo 5).

Kor stabilite testleri ve patlayıcı güç test sonuçları iki grup karşılaştırıldığında; kor enduransının değerlendirildiği sağ lateral köprü testi (p<0,001), sol lateral köprü testi (p<0,001), yüz üstü köprü testi (p<0,001) ve gövde fleksör testinde (p=0,033) çalışma grubunun sonuçlarının kontrol grubuna göre kor enduransı anlamlı olarak daha yüksek bulundu. Gövde ekstansör testi için ise çalışma ve kontrol grubu arasında endurans değeri açısından istatistiksel olarak anlamlı bir farklılık bulunmadı (p=0,062) (Tablo 5). Durarak uzun atlama testi için, iki grup karşılaştırıldığında çalışma grubunda kontrol grubuna göre atlama mesafelerinin istatistiksel olarak daha fazla olduğu bulundu (p<0,001) (Tablo 5).

TARTIŞMA

Bu çalışmada adölesan kadın basketbolcularda, kor stabilite ile denge ve alt ekstremite patlayıcı gücü ile olan ilişkinin değerlendirilmesi amaçlanmıştır. Bu nedenle 10-15 yaş aralığındaki adölesan kadın basketbolcular ve basketbol oynamayan adölesan kadınlar karşılaştırılmıştır. Çalışma sonucunda grup içi karşılaştırmalarda kor enduransı ve alt ekstremite patlayıcı gücü arasında ilişki bulunurken, denge ile kor enduransı ve patlayıcı güç arasında ise ilişki bulunmadı. Adölesan kadın basketbolcular ise basketbol olmayan adölesan kadınlara göre denge, patlayıcı güç ve kor enduransı açısın-

dan daha iyi bulunmuştur.

Yapılan araştırmalarda kor kasları içerisindeki derin gövde kaslarından transversus abdominis ve multifidus kaslarının, alt ekstremite hareketlerinden hemen önce aktive olarak, hareket öncesi gövde stabilizasyonu sağladığı ve bu stabilizasyonun, hareketlerin motor verimliliğini arttırdığı gösterilmektedir (6,11,25,26). Literatür ile benzer şekilde bu çalışmada da alt ekstremite patlayıcı güç değerlendirmesi ile gövde fleksör testi hariç kor stabilite testleri ile çok yüksek düzeyde ilişki bulunmuştur. Çalışmada elde edilen veriler doğrultusunda basketbol sporunda zayıf patlayıcı güç varlığında antrenman programlarına kor enduransı geliştirecek egzersizlerin eklenebileceği düşünülmektedir.

Yapılan bir çalışmada Hoppe ve diğ., erkek elit hokey sporcularında kor enduransı ile güç arasındaki ilişkiyi incelemiştir ve çalışma sonucunda kor enduransı ve güç arasında ilişki bulamamışlardır (27). 2008'de futbolcularda kor enduransı ve alt ekstremite patlayıcı gücü arasındaki ilişkiyi inceleyen başka bir çalışmada ise kor enduransı ve alt ekstremite gücü arasında orta derece bir ilişki gösterilmiştir (8,28). Literatür taramasında, çeşitli sporlara katılan sporcuların kor endurans ile patlayıcı güç verileri arasındaki ilişkiyi inceleyen çalışmalar olsa da, adölesan kadın basketbolcularda ilgili ilişkileri inceleyen bi çalışma bulunmamıştır. Bu nedenle çalışmamız sonucunda elde edilen veriler ile literatür verilerinin çelişkili olmasının sebebinin spor dalı, yaş ve cinsiyet faktörlerinden kaynaklı olabileceği düşünülmektedir.

Kor enduransının ve vücut dengesinin spor ve aktivitelerde iyi performans göstermesi açısından kritik öneme sahip olduğu bildirilmiştir (24,29). Kor stabilite, nöromusküler kontrol ve denge, alt ekstremitede fonksiyonun en üst seviyeye çıkmasını sağlamaktadır. Yapılan bir çalışma kadın üniversite öğrencilerinde dinamik denge ve kor enduransı arasındaki ilişkiyi incelemiş ve çalışma sonucunda kor stabilitenin denge ile ilişkisinin olmadığı gösterilmiştir (30). Adölesan badminton sporcularında kor endurans egzersiz eğitiminin, denge üzerine etkilerini inceleyen bir araştırmada 6 haftalık egzersiz eğitiminin kor enduransı ve dengeyi geliştirdiği gösterilmiştir (31). Sağlıklı yetişkinlerin kor endurans eğitimine dahil edildiği bir çalışmada ise 8 haftalık egzersiz eğitiminin dengeyi geliştirmediği gösterilmiştir (32). Kor enduransı ile denge arasındaki ilişkiyi gösteren veriler çelişkilidir. Bu çalışmada elde ettiğimiz verilere göre ise denge ve kor enduransı arasında istatistiksel olarak anlamlı bir ilişki bulunamadı. Bunun nedeni basketbol sporunun doğası, adölesan ve kadın popülasyonun seçilmesi olabilir. Ancak kadın adölesan basketbolcularda denge ve kor enduransı arasında bir ilişki bulunmasa da denge ve kor enduransının diğer komponentleri arasında ilişki olabileceği düşünülmektedir. Çalışmamızda kor endurans ile patlayıcı güç arasında ilişki varken denge parametreleri arasında ilişki bulunmamıştır. Kor kaslarının alt ekstremite hareketlerinden önce aktive olarak ekstremite hareketlerine destek sağladığı bilinmektedir. Çalışmamızda bu iki faktör arasında ilişki değerlerinin farklı olmasının sebebinin güç parametresinde kuvvet ve hız gerekirken; dengede koordinasyon, kas kuvveti, görsel ve vestibüler girdilerin önemli olmasından kaynaklandığı düşünülmektedir (14).

Patlayıcı gücün çocuk ve adölesan bireylerin dengesine pozitif etkileri olabileceği gösterilmiştir. Ancak bu konuda literatürde daha fazla çalışmaya ihtiyaç olduğu bildirilmiştir (24,33). Hammami ve diğ., futbolcularda yaptıkları çalışmanın sonucunda gençlerde denge ve alt ekstremite patlayıcı gücü arasında yüksek bir ilişki bildirmiştir (34). Yetişkinlerde, adölesanlarda ve çocuklarda denge ve patlayıcı güç arasındaki ilişkiyi araştıran çalışmalarda anlamlı bir ilişki bulunmuştur (32,35). Granacher ve diğ. adölesanlarda denge ve alt ekstremite gücü arasındaki ilişkiyi değerlendirmiştir. Bu çalışmanın sonucuna göre denge ve alt ekstremite patlayıcı gücü arasında zayıf bir ilişki bulmuşlardır (36). Kadın adölesan basketbolcularda dinamik denge ve alt ekstremite patlayıcı gücü arasındaki ilişkiyi değerlendiren herhangi bir çalışmaya ise rastlanmamıştır. Kadın adölesan basketbolcularda denge ve alt ekstremite patlayıcı gücü arasındaki ilişkiye bakılan bu çalışmada, bu iki parametre arasında anlamlı bir ilişki bulunmadı. Bir sistematik derlemede, farklı yaş gruplarında (çocuk, adölesan, genç yetişkin ve yetişkin) denge ve alt ekstremite patlayıcı kuvvet değerleri incelenmiştir. İlgili çalışmada denge ve patlayıcı kuvvet verilerinin, yaş ve cinsiyet gruplarına göre değiştiği bulunmuştur (35). Bu çalışmadan elde edilen bilgiler doğrultusunda, çalışmamızda elde edilen verilerin literatürden farklı olmasının nedenleri arasında yaş ve cinsiyet faktörleri olabi-

lir. Diğer bir neden ise bahsedilen çalışmada statik denge değerlendirilirken, bu çalışmada dinamik dengenin değerlendirilmesi olabilir.

Çalışmamızda basketbol oynayan ve oynamayan grup dinamik denge açısından karşılaştırıldığında, basketbol oynayan grubun denge mesafeleri anlamlı olarak daha iyi bulunmuştur. Denge basketbol sporu için önemli bir beceridir (1). Basketbol, dinamik yapısı gereği sürekli değişen hareketler içerir ve yoğun fiziksel etkileşimler basketbolcuları tekrarlı fiziksel streslere maruz bırakmaktadır (1,9). Basketbol sporundaki sürekli yer değiştirmeler ve değişen hareketlerin dengeyi geliştirdiği gösterilmiştir (37). Bu bağlamda, çalışmamızda, basketbol oynayan gruptaki oynamayan gruba göre olan dengenin daha iyi olmasının sebebinin spora katılım olduğu düşünülmektedir. Katıldıkları basketbol sporunda sürekli olarak maruz kaldıkları fiziksel stresler ve spor içerisinde yer alan yer ve yön değiştirmelerin daha fazla olması dengeyi geliştirmiş olabilir. Bunun yanı sıra patlayıcı güç, sıçrama ve yön değiştirme dahil olmak üzere basketbola özgü birçok aktivitenin yapılmasına katkıda bulunur (17,18). Çalışmamızda basketbolcularda basketbolcu olmayanlarla karşılaştırıldığında kor endurans ve patlayıcı güç verileri anlamlı olarak daha farklı bulunmuştur. Bunun sebebi, basketbol sporu için gerekli olan hareketlerin kor enduransı ve patlayıcı güç parametrelerine bağımlı olması olabilir.

Veriler sonucunda çalışmanın hipotezlerinin ikisi de kısmi olarak gerçekleşmiştir. Çalışmadan elden edilen veriler içerisindeki kor enduransı ve alt ekstremite patlayıcı gücü arasındaki pozitif yöndeki anlamlı ilişkinin, kor kasları ve alt ekstremite arasındaki bağlantıdan kaynaklandığı düşünülmektedir. Kor kasları, alt ekstremitenin hareketlerinden önce aktive olarak ekstremite hareketlerine destek sağlamakla birlikte gövde de stabilizasyon oluşturmaktadır (11).

Kor kaslarının stabilizasyonunun izole değerlendirilmesinde klinikte kullanılan fonksiyonel testlerin standardizasyonunun olmaması nedeniyle; bu testlerin çalışmada kullanımı çalışmanın limitasyonlarındandır. Spora başlama yaşının sorgulanmamış olması ve bu çalışmaya yalnızca adölesan kadın basketbolcuların dahil edilmesi de çalışmanın limitasyonlarıdır.

Sonuç olarak çalışmada adölesan kadın basketbolcularda, kor enduransı ile denge arasında anlamlı bir ilişki bulunmazken; kor enduransı ile alt ekstremite patlayıcı gücü arasında istatistiksel olarak çok yüksek seviyede anlamlı bir ilişki bulundu. Adölesan kadın basketbolcular, basketbol olmayan adölesan kadınlara göre denge, patlayıcı güç ve kor enduransı açısından daha iyiydi. Daha kesin sonuçlar ve basketbol yaralanma risk faktörlerinin ilişkisinin gösterilmesi için; kadın adölesan basketbolcularda kor stabilitenin komponentleri ile fiziksel uygunluk parametreleri arasındaki ilişkiyi değerlendirecek daha fazla çalışmaya ihtiyaç duyulmaktadır. Söz konusu ilişkinin ortaya çıkarılmasının, kor endurans egzersizlerinin antrenman programlarında yer almasının uzun vadede sporcu yaralanmalarının önlenmesinde önemli olabileceği düşüncesindeyiz.

Destekleyen Kuruluş: Destekleyen kuruluş bulunmamaktadır.

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Teşekkür: Çalışmaya gönüllü olarak katkı sağlayan bütün katılımcılara teşekkürler.

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PHYSICAL ACTIVITY IN PATIENTS WITH CHRONIC VENOUS INSUFFICIENCY: ITS RELATION WITH DISEASE SEVERITY, PAIN, FATIQUE, AND FUNCTIONALITY

ORIGINAL ARTICLE

ABSTRACT

Purpose: Chronic venous insufficiency (CVI) is a progressive disease of the venous system caused by a variety of factors that impair the return of venous blood to the heart. The aim of the study was to evaluate the physical activity level in patients with CVI and its relation with disease severity, pain, fatigue, functionality.

Methods: In all, 105 CVI patients (28.6% male, 71.4% female, mean age was 44.91±10.74 years) were enrolled in this study. Physical activity was evaluated with the International Physical Activity Questionnaire-Short Form (IPAQ-SF); disease severity, by Venous Clinical Severity Score (VCSS); the intensity of pain was determined by the Visual Analog Scale (VAS); fatigue level with the Fatigue Severity Scale (FSS); functionality was assessed with the Lower Extremity Function Scale (LEFS).

Results: There was a significant negative correlation between IPAQ-SF-vigorous and VCSS, VASrest, VASactivity, VASnight (r: -0.818, p<0.001; r:0.-445, p:0.007; r:-0.392, p:0.020; r:-0.363, p:0.032, respectively). A negative correlation was found between IPAQ-SF-moderate and VCSS, VASactivity (r:-0.473, p:0.004; r:-0.553, p:0.001, respectively). In addition, there was a negative correlation between IPAQ-SF total score and VCSS, VASrest, VASactivity, and a positive correlation with LEFS (r:-0.945, p<0.001; r:-0.368, p:0.030; r: -0.568, p<0.001; r:0.438, p: 0.009, respectively).

Conclusion: An increased level of physical activity was found to be associated with disease severity, pain, and functionality in patients with CVI.

Keywords: disease severity; fatigue; pain; physical activity; venous insufficiency

KRONİK VENÖZ YETMEZLİĞİ OLAN HASTALARDA FİZİKSEL AKTİVİTE: HASTALIK ŞİDDETİ, AĞRI, YORGUNLUK VE FONKSİYONELLİK İLE İLİŞKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Kronik venöz yetmezlik (KVY), venöz kanın kalbe dönüşünü bozan çeşitli faktörlerin neden olduğu, venöz sistemin ilerleyici bir hastalığıdır. Çalışmanın amacı, KVY hastalarında fiziksel aktivite düzeyinin hastalık şiddeti, ağrı, yorgunluk ve fonksiyonellik ile ilişkisinin değerlendirilmesidir.

Yöntem: Çalışmaya KVY' li toplam 105 hasta (%28,6'ı erkek, %71,4' ü kadın, ortalama yaşları 44,91±10,74 yıl) alındı. Katılımcıların fiziksel aktivite düzeyi, Uluslararası Fiziksel Aktivite Anketi-Kısa Formu (IPAQ-SF) ile; hastalık şiddeti, Venöz Klinik Şiddet Skoru (VKŞS) ile; istirahat, aktivite ve gece ağrılarının şiddeti Görsel Analog Skala (GAS) ile; yorgunluk düzeyi, Yorgunluk Şiddeti Ölçeği (FSS) ile; fonksiyonellik, Alt Ekstremite Fonksiyon Ölçeği (AEFÖ) ile değerlendirildi.

Sonuçlar: IPAQ-SF-şiddetli ile VKŞS, GAS-dinlenme, GAS-aktivite, GAS-gece arasında negatif korelasyon bulundu (r:-0,818, p<0,001; r:-0,445, p:0,007; r:-0,392, p:0,020; r:-0,363, p:0,032, sırasıyla). IPAQ-SF-orta ile VKŞS ve GAS-aktivite arasında negatif korelasyon mevcuttu (r:-0,473, p:0,004; r:-0,553, p:0,001, sırasıyla). Ayrıca IPAQ-SF toplam puanı ile VKŞS, GAS-dinlenme, GAS-aktivite arasında negatif, AEFÖ ile pozitif korelasyon vardı (r:-0,945, p<0,001; r:-0,368, p:0,030; r: -0,568, p<0,001; r:0,438, p:0,009, sırasıyla).

Tartışma: KVY'li hastalarda artmış fiziksel aktivite düzeyi ile hastalık şiddeti, ağrı ve fonksiyonellik arasında ilişki olduğu görüldü.

Anahtar Kelimeler: hastalık şiddeti, yorgunluk, ağrı, fiziksel aktivite, venöz yetmezlik

INTRODUCTION

Chronic venous insufficiency (CVI) is a progressive condition of the venous system, resulting from various factors that impair the return of venous blood to the heart (1). Dysfunction of the venous system leads to blood accumulation in the extremities, causing venous hypertension, pain, edema, heaviness, itching, cramps, and varicose veins in the lower limbs. In advanced stages, venous ulcers may develop (2). As the severity and duration of the disease progress, the impaired venous return may no longer be compensated, leading to a reduction in cardiac output (3). In the presence of venous hypertension in the lower extremities, elevated intravascular pressure exerts force on the venous walls, resulting in vascular dilation and tortuosity, which ultimately leads to the formation of varicose veins. The inability of the smooth muscle in the venous walls to contract effectively prevents the veins from narrowing sufficiently to direct blood back to the heart, and the function of the venous valves is also compromised. Dysfunction of these valves can further exacerbate the condition (4). This creates a vicious cycle that worsens the symptoms. Both the lower extremity symptoms and reduced cardiac output are often associated with decreased physical activity (PA), reduced functional capacity, increased fatigue and exercise intolerance. In CVI patients, pain and increased edema are the most common complaints, especially with prolonged standing or sitting with the feet dangling. These symptoms may limit functionality and participation in daily activities (5). Additionally, pain can make prolonged walking, heavy lifting, stair climbing, and other activities difficult, with many patients reporting an inability or difficulty in performing activities such as jogging, jumping, and running (6). Consequently, a decrease in daily PA levels may be an inevitable outcome.

The primary factor negatively affecting PA in CVI patients is the pain associated with swollen legs, which can lead to a fear of movement (7). Literature also reports decreased ankle joint range of motion, reduced calf muscle strength and pumping function, and slowed walking in these patients, all of which further impair overall mobility and PA levels (8, 9). Previous studies have documented low PA levels and the associated factors in patients with venous ulcers (6, 10, 11). Patients with venous ulcers often struggle to maintain an active lifestyle due to concerns about the wound being irritated or leaking, the need to wear specialized footwear, or the inability to wear shoes at all (12). Evaluating the PA levels and related factors in patients without venous ulcers is crucial for implementing preventive measures and encouraging patient engagement in PA before the development of wounds.

The aim of this study is to evaluate PA in patients with CVI and examine the associations between PA and disease severity, pain, fatigue, and functionality.

METHODS

Participants

It was a cross-sectional study. Patients with CVI who met the inclusion criteria were referred the Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, from the Department of Cardiovascular Surgery at University Hospital between January and June 2022. The University Ethics Committee granted ethical permission for this investigation under decision number (08.9.2021/ No:142). The principles of the Declaration of Helsinki were adhered to in the conduct of this investigation. Two informed consent forms were sent to each participant in the study, with one copy being retained by the individual, and their signed consent was acquired.

The study's inclusion requirements included having a duplex ultrasound diagnosis of CVI between the ages of 18 and 65, falling into CEAP (Clinical, Etiological, Anatomical, Pathophysiological) categorization system class C2-C3-C4-C5, and having written and spoken communication skills. Acute deep vein thrombosis, ulceration, classification as C1 or C6, chemotherapy for any cancer, a diagnosed mental illness requiring prescription medication, and treatment for a neurological, orthopaedic, or rheumatological condition affecting the lower limb were among the exclusion criteria.

Assessments of PA, pain severity, fatigue and functionality were carried out by a physiotherapist, while a cardiovascular surgeon performed assessments of clinical class and disease severity. All of

the assessments were completed on the same day, in separate rooms, and without any interaction between the assessors because they were blind to one another. A face-to-face interview method was used for data collection. The researchers provided advice if the patients had any questions. It took around 20 minutes to finish all assessment.

For this study, 105 patients, 75 of whom were female and ranging in age from 18 to 65 years, were included.

Sample Size

We used the Raosoft Sample Size Calculator application to determine the appropriate sample size for our investigation with an 80% confidence interval, 5% margin of error, 50000 general population and 20% (10%-30%) prevalence. The result of the calculation was that a total of 105 participants should be included (13).

Assessments

Using an assessment form, demographic and clinical features were noted. The participants' age, gender, height, weight, length of time since CVI onset, and clinical classification were all given on the assessment form.

The CEAP classification system was used to categorize the patients. This system defines clinical signs (C), etiology (E), anatomical features (A) and underlying pathophysiological event (P). Six degrees of clinical data are categorized based on how severe the event was: Normal is C0; spider/reticular veins are C1; varicose veins are C2; oedema is C3; skin alterations are C4; healed ulcers are C5, and active ulcers are C6 (14).

PA levels were assessed using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The questionnaire consists of seven questions that ask about the total time of light, moderate, and vigorous activity during the past seven days. The equivalents of 3.3 metabolic equivalents (METs) for light activity, 4.0 METs for moderate activity and 8.0 METs for vigorous activity were taken, and activity levels were calculated by multiplying the METs of the activities by the durations reported by the individuals, and the PA level of the individuals was recorded in MET-min/week as a result of the calculation (15). The Turkish validity and reliability study of the questionnaire was conducted by Saglam et al. (16).

Disease severity was evaluated by the VCSS. VCSS assesses pain caused by venous insufficiency, varicose veins, oedema, skin pigmentation, inflammation, induration, number of active ulcers, duration and diameter of active ulcers, need of using compression stockings. Every item has a score ranging from 0 to 3. '3' denotes severe, and '0' denotes none. Poor clinical condition is indicated by a high score, and excellent clinical condition is indicated by a low score. On the VCSS, 0 is the lowest possible score and 30 is the highest (17).

The pain intensity were assessed using the Visual Analogue Scale (VAS). They were asked to rate their pain on a 10 cm scale from 0 to 10, with 0 indicating no pain and 10 indicating excruciating agony. They were asked about the pain they experienced at night, during activity, and at rest (18).

The level of fatigue was evaluated using the Fatigue Severity Scale (FSS). The questionnaire contains nine items, each with a score ranging from one to seven. A score of one indicates significant disagreement with the statement, while a score of seven shows strong agreement with it. The overall score is calculated by adding all the scores and dividing by nine. The higher the total score, the more intense the tiredness (19). The Turkish validity and reliability study of the questionnaire was conducted by Gencay-Can et al. (20).

The functionality was evaluated by the Lower Extremity Functional Scale (LEFS). The LEFS is a questionnaire with 20 items that evaluates difficulty carrying out daily tasks. Each activity is scored from 0 to 4. '0' indicates excessive difficulty or inability to perform the activity and '4' indicates no difficulty. The score obtained from the questionnaire ranges from 0 to 80. High scores indicate good functionality, low scores indicate poor functionality (21). The Turkish validity and reliability study of the questionnaire was conducted by Citaker et al. (22).

Statistical analysis

All analyses were carried out using SPSS (IBM Corp., Armonk, New York, USA Statistical Package for Social Sciences) for Windows 22. The data's

normality was evaluated using histograms and the Kolmogorov-Smirnov test. The mean and standard deviation were used to define the variables. Data that did not fit into a normal distribution were subjected to correlation analysis using the Spearman correlation test. The Kruskal-Wallis test was used to compare PA, disease severity, pain, fatigue and functionality between groups according to clinical classes. $p<0.05$ was considered statistically significant (23).

RESULTS

113 consecutive patients were screened for possible eligibility criteria. Three participants were withdrawn from the study for some personal reasons, and five of these were unable to complete the assessments correctly. 105 patients who satisfied the requirements for participation decided to take part. Their mean age was 44.91±10.74 years and BMI was 33.28±7.51 kg/m2. The demographic and clinical features of the patients are shown in Table 1.

Correlation between PA and disease severity, pain, fatigue, functionality were shown in Table 2. A neg-

Table 1. Demographic and Clinical Features of Patients with CVI

Variables	Patients (n=105) Mean ± SD
Age (years)	44.91±10.74
BMI (kg/m^2)	33.28±7.51
Time since CVI onset (years)	12.34±7.74
VCSS (0-30)	13.66±5.13
VAS-rest (0-10)	4.79±3.01
VAS-activity (0-10)	5.23±2.78
VAS-night (0-10)	3.71±2.84
FSS	4.60±1.48
LEFS	44.49±17.75
IPAQ-SF-vigorous	286.86±352.13
IPAQ-SF-moderate	248.00±238.18
IPAQ-SF-light	524.23±222.49
IPAQ-SF-total	1059.09±411.20
Gender	n (%)
Female	75 (71.4)
Male	30 (28.6)
CEAP classification (Clinical)	n (%)
C2	12 (11.4)
C3	45 (42.9)
C4	30 (28.6)
C5	18 (17.1)

SD: Standard Deviation, BMI: Body Mass Index, VCSS: Venous Clinical Severity Score, VAS: Visual Analog Scale, FSS: Fatigue Severity Scale, LEFS: Lower Extremity Functional Scale, IPAQ-SF: International Physical Activity Questionnaire-Short Form.

Table 2. The Relationship Between Physical Activity and Disease Severity, Clinical Class, Pain, Fatigue, Functionalitiy Assessments in Patients with CVI

Variables		IPAQ-SF-vigorous	IPAQ-SF-moderate	IPAQ-SF-light	IPAQ-SF-total	VCSS	CEAP	VAS-rest	VAS-activity	VAS-night	FSS	LEFS
IPAQ-SF-vigorous	rh_o	1.000	0.236	-0.494	0.777	-0.818	-0.627	-0.445	-0.392	-0.363	-0.259	0.296
	p	.	0.173	0.003*	0.000*	0.000*	0.000*	0.007*	0.020*	0.032*	0.134	0.084
IPAQ-SF-moderate	rh_o	0.236	1.000	-0.218	0.580	-0.473	-0.294	-0.206	-0.553	-0.094	0.029	0.264
	p	0.173	.	0.208	0.000*	0.004*	0.086	0.236	0.001*	0.592	0.867	0.126
IPAQ-SF-light	rh_o	-0.494	-0.218	1.000	-0.104	0.203	0.161	0.279	0.134	0.058	0.056	0.034
	p	0.003*	0.208	.	0.554	0.241	0.357	0.105	0.444	0.739	0.750	0.846
IPAQ-SF-total	rh_o	0.777	0.580	-0.104	1.000	-0.945	-0.726	-0.368	-0.568	-0.326	-0.268	0.438
	p	0.000*	0.000*	0.554	.	0.000*	0.000*	0.030*	0.000*	0.056	0.119	0.009*
VCSS	rh_o	-0.818	-.0473	0.203	-0.945	1.000	0.742	0.424	0.492	0.381	0.355	-0.487
	p	0.000*	0.004*	0.241	0.000*	.	0.000*	0.011*	0.003*	0.024*	0.036*	0.003*
CEAP	rh_o	-0.627	-0.294	0.161	-0.726	0.0742	1.000	0.286	0.395	0.385	0.280	-0.311
	p	0.000	0.086	0.357	0.000	0.000	.	0.096	0.019	0.023	0.103	0.069
VAS-rest	rh_o	-0.445	-0.206	0.279	-0.368	0.424	0.286	1.000	0.654	0.369	-0.268	-0.332
	p	0.007*	0.236	0.105	0.030*	0.011*	0.096	.	0.000*	0.029*	0.119	0.052
VAS-activity	rh_o	-0.392	-0.553	0.134	-0.568	0.492	0.395	0.654	1.000	0.276	.246	-0.383
	p	0.020*	0.001	0.444	0.000	0.003*	0.019*	0.000*	.	0.108	.154	0.023
VAS-night	rh_o	-0.363	-0.094	0.058	-0.326	0.381	0.385	0.369	0.276	1.000	0.389	-0.386
	p	0.032*	0.592	0.739	0.056	0.024*	0.023*	0.029*	0.108	.	0.021*	0.022*
FSS	rh_o	-0.259	0.029	-0.056	-0.268	0.355	0.280	0.278	0.246	0.389	1.000	-0.851
	p	0.134	0.867	0.750	0.119	0.036*	0.103	0.105	0.154	0.021*	.	0.000*
LEFS	rh_o	0.296	0.264	0.034	0.438	-.487	-0.311	-0.332	-0.383	-0.386	-0.851	1.000
	p	0.084	0.126	0.846	0.009*	0.003*	0.069	0.052	0.023*	0.022*	0.000*	.

rh_o: Spearman correlation test; (Negative values show reverse relation) IPAQ-SF: International Physical Activity Questionnaire-Short Form, VCSS: Venous Clinical Severity Score, CEAP: Clinical, Etiological, Anatomical, Pathophysiological Classification System, VAS: Visual Analog Scale, FSS: Fatigue Severity Scale, LEFS: Lower Extremity Functional Scale.

Table 3. Comparison of Physical Activity, Disease Severity, Pain, Fatigue, Functionality According to CEAP (clinical)

Variables	IPAQ-SF-vigorous	IPAQ-SF-moderate	IPAQ-SF-light	IPAQ-SF-total	VCSS	VAS-rest	VAS-activity	VAS-night	FSS	LEFS
C2	960.00±257.54	240.00±265.87	371.25±85.73	1571.25±111.99	7.50±1.16	4.25±1.35	5.75±0.86	2.00±1.65	3.63±1.74	46.75±22.67
C3	298.67±261.27	328.00±200.47	561.00±262.77	1187.67±309.98	11.87±2.76	3.00±3.13	3.93±2.29	3.13±2.73	4.56±1.26	46.87±12.10
C4	172.00±234.45	268.00±260.53	534.60±175.56	974.60±343.41	12.75±3.13	4.40±2.62	5.30±3.15	3.90±2.42	4.32±1.52	49.90±21.52
C5	0.00±0.00	20.00±46.01	517.00±201.52	537.00±162.55	22.33±1.94	6.17±2.87	8.00±1.68	6.00±2.97	5.81±0.87	28.00±5.66
p	0.000*	0.000*	0.018*	0.000*	0.000*	0.002*	0.000*	0.001*	0.000*	0.000*

p: Kruskal Wallis Test, SD: Standard Deviation, IPAQ-SF: International Physical Activity Questionnaire-Short Form, VCSS: Venous Clinical Severity Score, CEAP: Clinical, Etiological, Anatomical, Pathophysiological Classification System, VAS: Visual Analog Scale, FSS: Fatigue Severity Scale, LEFS: Lower Extremity Functional Scale.

ative correlation was found between IPAQ-SF-vigorous and VCSS, VASrest, VASactivity, VASnight (r:-0.818 p<0.001; r:-0.445 p<0.007, r:-0.392 p<0.020, r:-0.363 p<0.032, respectively). A negative correlation was found between IPAQ-SF-moderate and VCSS, VASactivity (r:-0.473 p:0.004; r:-0.553 p<0.001, respectively). There was a negative correlation between IPAQ-SF total value and VCSS, VASrest, VASactivity and a positive correlation with LEFS (r:-0.945 p<0.001, r:-0.368 p:0.030, r:-0.568 p<0.001, r:0.438 p:0.009, respectively).

Comparison of PA, disease severity, pain, fatigue, functionality according to CEAP (clinical) were shown in Table 3. Patients were in C2 had the highest level of IPAQ-SFvigorous and IPAQ-SFtotal, while patients were in C3 had highest level of IPAQ-SFmoderate and IPAQ-SFlight (p<0.05).

DISCUSSION

This study demonstrated that as the time and energy dedicated to PA increased, both disease severity and pain (at rest and during activity) decreased, while functionality improved. As the vigorous PA increased, disease severity and pain (at rest, during activity, and at night) were reduced. Increasing moderate PA also led to a reduction in both disease severity and the intensity of pain experienced during activity. However, light PA had no significant effect on disease severity, pain, fatigue, or functionality.

Heinen et al., found that moderate-intensity PA was low compared with healthy controls using an accelerometer, and 35% of patients who have venous ulcers did not walk for 10 minutes even once a week (11). Kiloatar et al., assessed that patients with early-stage CVI (C2-C3 class) exhibited low levels of quality of life (QoL) and PA, along with moderate pain intensity. They concluded that low levels of PA in the early stages of the disease could contribute to disease progression (24). Keser et al., investigated differences in pain, fatigue, and QoL in patients with CVI based on PA level and demonstrated that the moderate-intensity PA group (n:32) had lower pain intensity, lower fatigue severity and higher points in QoL scores than the light-intensity PA group (n:17) and the vigorous-intensity PA group (n:20). Their results showed that a moderate-intensity PA could significantly decrease pain during activity and fatigue in patients with CVI (7). Erdal et al., showed that the IPAQ total score was significantly lower in patients with CVI than in healthy controls. Low PA scores were associated with higher pain intensity during activity and lower functional capacity (25). Espeit et al., investigated the relationship between PA and both fatigue and QoL in people with self-reported symptoms of chronic venous disease (CVD). Their results demonstrated that a higher levels of PA is associated with less fatigue and a tendency toward improved QoL in this population (26). However, Alberti et al., divided patients with CVD into two groups: those who participated in regular PA for more than two years and those who were sedentary. According to this study, there was no relationship between the practice of PA and the occurrence of CVI of the lower limbs, but PA prevented the development of this disease to more severe stages (27). Patients in C2 had the highest level of vigorous PA and total PA, while patients in C3 had the highest level of moderate and light PA in our study. As levels of vigorous and total PA increased, clinical class, disease severity and pain intensity decreased. Increasing the total time and energy spent on PA improved their

functionality. These improvements may be due to increased venous return, decreased calf muscle dysfunction, increased foot-ankle mobility and improved cardiovascular fitness as time and intensity of PA increase. The results of our study emphasise that as participation and intensity of PA increase, symptoms of the disease improve. One of the results of our study, which is different from the studies in the literature, is that activities at the level of light PA are not effective on disease severity, pain, fatigue and functionality. The importance of the activity level and the activity performed should be explained to patients, and physiotherapists should take these results into account when determining the appropriate and effective activity intensity for their patients.

In addition, Tauragingskii et al., examine the immediate effect of PA on venous reflux and according to their results venous reflux decreases within 1 minute after the end of PA. These objective conclusions suggest that PA is essential and crucial in patients with CVI (28).

The strong correlation between PA levels and disease severity in our study may play a key role in the rehabilitation of patients. Aydin et al., reported that there was a negative correlation between disease severity and both venous return and functional capacity in patients with CVI (29). Decreased functional capacity, which is associated with increasing disease severity, may limit participation in activities and may lead to rapid fatigue. Yeldan et al., investigated disease severity and its relationship with clinical outcomes such as pain, oedema and functional capacity in patients with CVI. According to their results, high disease severity is associated with high pain (assessed by VAS) and oedema and low functionality (assessed by LEFS) in patients with CVI without leg ulcers. However, there was no relationship between disease severity and functional capacity. They added that the fact that disease severity increased the severity of pain and oedema, but did not affect functional capacity, may be due to the young age of most patients (30). In our study, vigorous and moderate PA had a positive effect on disease severity, whereas light PA had no effect. In parallel with the literature, our study showed that VCSS increased in a strong linear relationship with higher CEAP clinical class. In addition, in our study, as disease severity increased, patients' pain intensity and fatigue increased and their functionality decreased. In this population, it is possible to improve disease severity and related symptoms by physiotherapists encouraging patients to participate in PA and increasing the intensity of activity with patient-specific planning. Increased pain intensity and, in parallel, decreased patient function and functionality are the main symptoms of CVI that patients have to cope with. In our study, increasing levels of vigorous PA reduced the intensity of pain at rest, during activity and at night. This may be because the pumping effect of the calf muscle increases and lasts longer as activity increases. It was also observed that activity and nocturnal pain levels increased as the clinical class of our patients increased. In addition, as the pain felt at night increased, so did the severity of fatigue increased and functionality decreased. This may be explained by the fact that pain experienced during sleep may disrupt sleep quality and that starting the day without rest may increase fatigue levels during the daytime. As a result, both activity participation and functionality may be negatively affected.

Fatigue is a common symptom of many chronic diseases and is often assessed using self-report scales. Espeit et al., showed an relationship between PA and fatigue levels in both participants with symptoms of CVD and participants at risk of chronic venous disease. In these groups, those who were insufficiently active had higher fatigue scores than those who were moderately active or active (26). Keser et al., in a small sample of CVI patients, reported a positive correlation between moderate-intensity PA level and fatigue severity and QoL, so it seemed from their results that the level of PA could have a positive impact on QoL by limiting fatigue (7). In our study, although there was no relationship between the PA levels of and the fatigue severity of the patients, as the fatigue severity decreased, disease severity, night-time pain decreased and functionality increased. Therefore, the relationship between FA and fatigue should be analysed in future studies with a larger sample size.

Limitations of this study include the fact that kinesiophobia, which may affect participation of patients in PA, was not assessed, and objective

assessment methods such as accelerometry could not be used to assess PA because of the current clinical conditions. Future studies could include objective measures of PA and the effects of different levels of PA on symptoms of patients.

In conclusion, more time and energy spent on total PA is associated with lower disease severity, pain intensity and increased functionality in patients with CVI. Therefore, PA is a crucial factor in preventing its adverse effects on disease severity, pain, and functionality in patients with CVI.

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PEDİATRİK REHABİLİTASYON DERS İÇERİĞİNİN FİZYOTERAPİ VE REHABİLİTASYON BÖLÜMÜ ÖĞRENCİLERİNİN VE MEZUNLARININ BAKIŞ AÇISI İLE İNCELENMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı, Haliç Üniversitesi Fizyoterapi ve Rehabilitasyon (FTR) lisans programındaki pediatrik rehabilitasyon (PFTR) ders içeriğinin öğrencilerin ve mezunların bakış açısı ile incelenmesidir.

Yöntem: Çalışmaya 2023-2024 yıllarında Haliç Üniversitesi FTR lisans programında eğitim gören 53 öğrenci (yaş: 21,79±1.19) ve aynı bölümden mezun olan 76 katılımcı (yaş:27,65±3,37) dahil edildi. Katılımcılara PFTR dersinin içeriği, müfredattaki dönem sayısı, laboratuvar saatleri ve dersin işleniş şekline yönelik olarak çevrimiçi anket soruları yöneltildi.

Sonuçlar: Her iki grup da PFTR dersinin müfredatta iki dönem olmasının daha uygun olacağını ve dersin laboratuvar saatlerinin yetersiz olduğunu belirtmişlerdir. Dersin içeriğinde en fazla zaman ayrılması gerektiği düşünülen konunun serebral palsi olduğu (lisans: %32,26; mezun: %72,37); başka derslerin içeriğinde olup PFTR dersinin içeriğine de eklenmesi gerektiği düşünülen konunun 'pediatrik ortopedik problemler ve ortezler' olduğu belirtilmiştir (lisans: %35,84; mezun: %82,89). Dersin işleniş şekilleri bakımından 'derse gerçek vakaların davet edilmesi' ders içeriğine katkısının en fazla olacağı düşünülen ek imkân olarak bildirilmiştir (lisans: %45,28; mezun: %78,94).

Tartışma: PFTR ders içeriğini ve dersin yapısı geliştirecek faktörler araştırılarak, öğrencilere pratik yetkinlik kazandırma konusunun kapsamlı olarak ele alınması gerektiği görülmektedir.

Anahtar Kelimeler: Eğitim, Fizyoterapistler, Müfredat, Pediatri, Profesyonel eğitim,

EXAMINATION OF PEDIATRIC REHABILITATION COURSE CONTENT FROM THE PERSPECTIVE OF PHYSIOTHERAPY AND REHABILITATION UNDERGRADUATE STUDENTS AND GRADUATES

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of this study was to investigate the perspectives of students and graduates regarding the pediatric rehabilitation (PFTR) course content of Haliç University Physiotherapy and Rehabilitation (PTR) undergraduate programme.

Methods: The study included 53 students (age: 21.79±1.19) studying at Haliç University PFTR undergraduate programme in 2023-2024 and 76 participants (age: 27.65±3.37) graduated from the same department. Participants took online survey about the content of the PFTR, the number of semesters, laboratory hours and the way the course was taught.

Results: Both groups (undergraduate: 62.26%; graduate: 81%) stated that it would be more appropriate for the PFTR course to be two semesters in the curriculum and that the laboratory hours were not enough (undergraduate: 47.17%; graduate: 89.51%). Cerebral palsy was the subject thought to be allocated the most time in the content of the course (undergraduate: 32.26%; graduate: 72.37%); and the subject that was in the other course contents and thought to be added to PFTR was 'paediatric orthopaedic problems and orthoses' (undergraduate: 35.84%; graduate: 82,89%). In terms of the teaching methods of the course, 'inviting real cases to the course' was reported as the additional opportunity that was thought to contribute the most (undergraduate: 45.28%; graduate: 78.94%).

Conclusion: The issue of providing students with practical competence should be addressed comprehensively by investigating factors that will improve the PFTR course content and course structure.

Keywords: Education, Physical therapists, Curriculum, Pediatrics, Professional education

GİRİŞ

Pediatrik fizyoterapi ve rehabilitasyon (PFTR) çeşitli konjenital, gelişimsel, nöromüsküler veya edinilmiş bozukluklar ve hastalıklara sahip olan ya da bu bozukluklar açısından risk altında olan bebek, çocuk ve adölesanların (0-18 yaş) tanı, tedavi ve yönetimine yardımcı olur. PFTR'de tedavi temel olarak kaba ve ince motor becerileri, denge ve koordinasyonu, güç ve dayanıklılığı geliştirmeye odaklanır (1).

Dünya geneline bakıldığında, PFTR alanında özelleşen fizyoterapistler toplum temelli rehabilitasyon merkezlerinde, hastanelerin ayakta tedavi ve yataklı servislerinde, özel rehabilitasyon merkezlerinde, okullarda ve birçok devlet destekli veya özel kurumlarda çalışabilmektedir (2) .

Ülkemizde Fizyoterapi ve Rehabilitasyon (FTR) eğitim müfredatı içerisinde PFTR dersinin eğitiminin ve uygulamalarının başlangıcı, fizyoterapistlik mesleğinin de başlangıcı olan 1961 yılında Hacettepe Üniversitesi Fizik Tedavi ve Rehabilitasyon Yüksekokulu'nun kuruluşuna dayanmaktadır. FTR lisans programı mezunlarının fizyoterapist unvanı kazandıkları, fakülte veya yüksekokul bünyesindeki 4 yıllık eğitimi kapsamaktadır. Şubat 2024 itibari ile Türkiye'de 101 üniversitede (fakülte veya yüksekokul) 4 yıllık FTR lisans eğitimi veren bölüm bulunmaktadır (3).

Artan üniversite ve bölüm sayısı ile, lisans eğitiminde standardizasyon sağlamak amacıyla FTR lisans eğitimi veren her bir kurumun müfredatının Fizyoterapi ve Rehabilitasyon Ulusal Çekirdek Eğitim Programı (FTR-ÇEP) doğrultusunda geliştirmesi ve güncellemesi önerilmektedir (4). Ancak ülkemizdeki lisans programı müfredatlarının ve PFTR ders içeriklerin ulusal bir standardizasyonu henüz bulunmamaktadır.

Gürses ve ark. (5) tarafından Türkiye'deki 4 yıllık FTR bölümleri için müfredat analizi çalışması yapılmıştır. Çalışmanın sonuçları PFTR dersi bağlamında incelendiğinde, PFTR ders içeriğinin farklı üniversitelerin müfredatlarda farklı isimlerde yer aldığı (Pediatrik Rehabilitasyon, Pediatrik Fizyoterapi ve Rehabilitasyon vb.) ve dersin okutulduğu dönem sayısı bakımından da farklılıklar olduğu görülmektedir.

Uluslararası literatürde, özellikle Amerika Birleşik Devletleri'nde (ABD) ve Avustralya'da olmak üzere, FTR mesleki eğitimi kapsamındaki PFTR dersinin içeriği ve eğitim metotları ile ilgili olarak yayınlanan rehberler, saha raporları ve öğrenci-mezun-akademisyen görüşlerinin incelendiği çalışmalar yer almaktadır (6–11). Türkiye'de ise PFTR dersini özel olarak inceleyen ya da öğrenci-mezun görüşlerini sorgulayan bir çalışmaya rastlanmamıştır. Bu nedenle çalışmamızın amacı "Pediatrik Rehabilitasyon" ders içeriği ve dersin yapısı hakkında öğrencilerin ve mezunların görüşlerinin incelenmesidir.

YÖNTEM

Bu çalışma gözlemsel kesitsel tasarımda ve çevrimiçi anket (Google Formlar) yolu ile 01.09.2023-10.01.2024 tarihleri arasında gerçekleştirilmiştir. Araştırmamızda pilot olarak Haliç Üniversitesi Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon lisans programında 3. sınıf güz müfredatında yer alan "Pediatrik Rehabilitasyon" dersinin içeriği, yapısı ve Haliç Üniversitesi Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon lisans programı öğrencileri ile aynı programın mezunları seçilmiştir. Haliç Üniversitesi Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon (Türkçe) lisans programında 3. ve 4. sınıfa devam edip pediatrik rehabilitasyon dersini almış olan öğrenciler ve aynı üniversitenin mezun olup pediatrik fizyoterapi alanında çalışan fizyoterapistler çalışmaya davet edilmiştir. Kartopu örnekleme yöntemi ile anketler sınıf temsilcilerine ve mezun dönem temsilcilerine mobil iletişim kanalları ve e-mail yolu ile ulaştırılmıştır.

Çalışmamızın veri toplama araçları "Lisans Öğrencisi Anketi" ve "Mezun Anketi" olmak üzere iki ayrı çevrimiçi anketten oluşmaktadır. Her iki anketin soruları için, literatürde yer alan çalışmalar örnek alınarak (2, 6, 12, 17) FTR-ÇEP ile karşılaştırılmış ve çalışmanın yapıldığı üniversitenin müfredatına uygun hale getirilmiştir. Yazarlar (D.B-B. ve A.M.) tarafından oluşturulan sorulara, PFTR alanında çalışan ve çalışma ile çıkar çatışması olmayan iki ayrı fizyoterapistten uzman görüşü alınarak son hali verilmiştir. Çalışma için Haliç Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulundan onay alınmıştır (19.06.2023/192). Uygulanan çevrimiçi anketlerin ilk basamağında katılımcılardan bilgilendirilmiş gönüllü onamı alınmıştır.

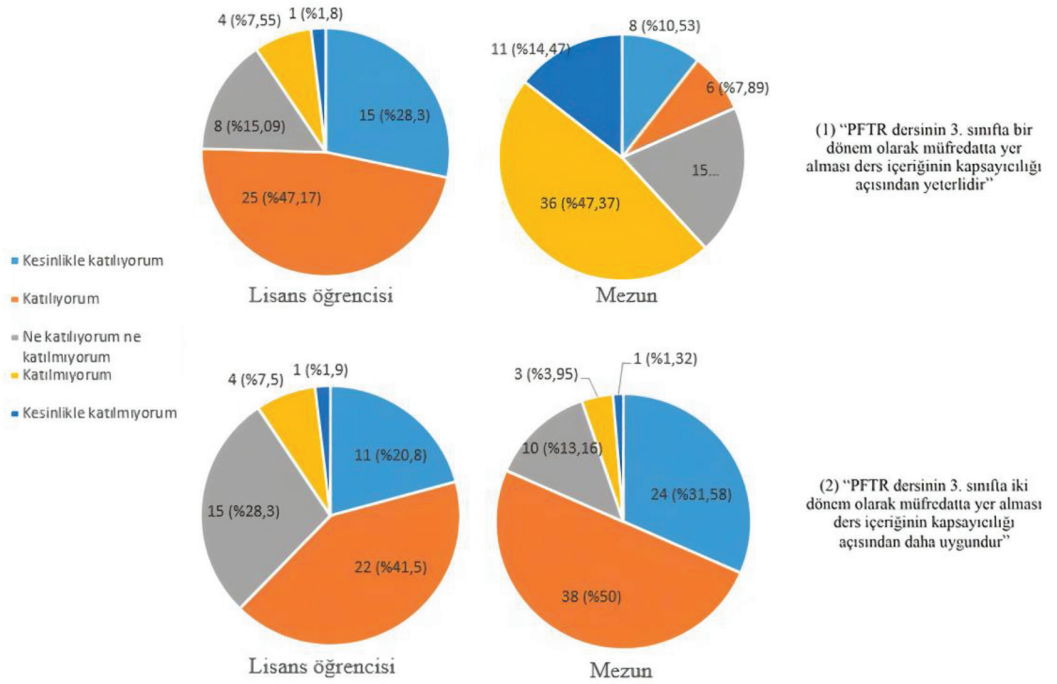
Lisans Öğrencisi Anketi

Lisans 3. ve 4. sınıf öğrencilerine gönderilen anket, öğrencilerin PFTR alanında staj yapma durumları, staj süresince karşılaştıkları tanı grupları, stajlardaki deneyimlerine dayanarak PFTR ders içeriğinde daha fazla zaman ayrılması gerektiğini düşündükleri konu başlıkları, PFTR dersinin müfredattaki ders saati, PFTR dersinde daha fazla zaman ayrılması gerektiğini düşündükleri konu başlıkları ve PFTR

Tablo 1. Katılımcılara ait tanımlayıcı özellikler

Lisans öğrencileri		
	Eğitim durumu	**n (%)**
	3. sınıf öğrencisi, PFTR dersini almış	27 (50,94)
	4. sınıf öğrencisi, PFTR stajı yapmamış	14 (26,41)
	4. sınıf öğrencisi, PFTR stajı yapmış	12 (22,64)
	Stajlar boyunca gözlemlenen pediatrik vaka (n)	
	1-5	14 (46,66)
	6-10	6 (20)
	11-15	5 (16,66)
	16-20	2 (6,66)
	>20	3 (10)
	Stajlar sırasında karşılaşılan tanı grupları	
	Serebral palsi	22 (66,66)
	Nöromüsküler hastalıklar	1 (3,03)
	Otizm spektrum bozukluğu	2 (6,06)
	Spina bifida	2 (6,06)
	Down sendromu ve diğer genetik sendromlar	2 (6,06)
	Diğer	4 (12,12)
	Mezuniyet sonrası PFTR alanında çalışmayı düşünür mü?	
	Evet	12 (35,3)
	Hayır	8 (23,5)
	Kararsız	14 (41,2)
Mezunlar		
	Eğitim durumu	**n (%)**
	Lisans mezunu	33 (43,42)
	Yüksek lisansa devam ediyor ya da yüksek lisans mezunu	42 (55,26)
	Doktoraya devam ediyor ya da doktora mezunu	1 (1,31)
	Fizyoterapist olarak çalışılan sene	
	<1	8 (10,52)
	1-5	53 (69,73)
	6-10	13 (17,10)
	>10	2 (2,63)
	Çocuklar çalışma grubunuzun ne kadarını oluşturmakta? (%)	
	<50	41 (53,94)
	50-99	29 (38,15)
	100	6 (7,89)
	Mezuniyet sonrası kurslara katılma	
	Evet	13 (17,10)
	Hayır	63 (82,89)
	Lisansüstü eğitiminin alındığı alan	
	Lisansüstü eğitim almadım	31 (40,78)
	Genel Fizyoterapi ve Rehabilitasyon	38 (50)
	Sporcu Sağlığı ve Rehabilitasyonu	1 (1,31)
	Ortopedik Rehabilitasyon	2 (2,62)
	Nörolojik Rehabilitasyon	1 (1,31)
	Kardiyopulmoner Rehabilitasyon	1 (1,31)
	Anatomi	1 (1,31)
	Nörobilim	1 (1,31)

PFTR: pediatrik rehabilitasyon dersi; >: büyüktür; n: kişi sayısı; %: yüzde



Şekil 1. Pediatrik Rehabilitasyon Dersinin Müfredattaki Dönem Sayısı ile İlgili Sorulara Verilen Cevapların Dağılımı

dersinin içeriğine eklenmesi gerektiğini düşündükleri konular, PFTR dersinin işleniş şekli ile alakalı olarak derse katkı sağlayacağı düşünülen imkân ve sorumluluklar hakkındaki düşüncelerinin sorulduğu toplam 11 adet açık ve kapalı uçlu sorudan oluşmaktaydı (EK-1).

Mezun Anketi

Haliç Üniversitesi Sağlık Bilimleri Fakültesi FTR bölümü lisans bölümü mezunlarına yönelik olarak Google Formlar üzerinden hazırlanan anket mezun öğrencilere mobil iletişim kanalları ile ulaştırılmıştır. Anket içerisinde mezunların lisans sonrası eğitim durumları, fizyoterapist olarak çalıştıkları sene sayısı, mezuniyet sonrasında PFTR alanında düzenlenen eğitim ve kurslara katılma durumları, pediatrik rehabilitasyon dersinin müfredattaki ders saati, çalışma hayatlarındaki deneyimlerine dayanarak PFTR ders içeriğinde daha fazla zaman ayırılması gerektiğini düşündükleri konu başlıkları, PFTR dersinin içeriğine eklenmesi gerektiğini düşündükleri konular, PFTR dersinin işleniş şekli ile alakalı olarak derse katkı sağlayacağı düşünülen imkân ve sorumluluklar hakkındaki düşüncelerinin sorulduğu toplam 15 adet açık ve kapalı uçlu soru yer almaktaydı (EK-2).

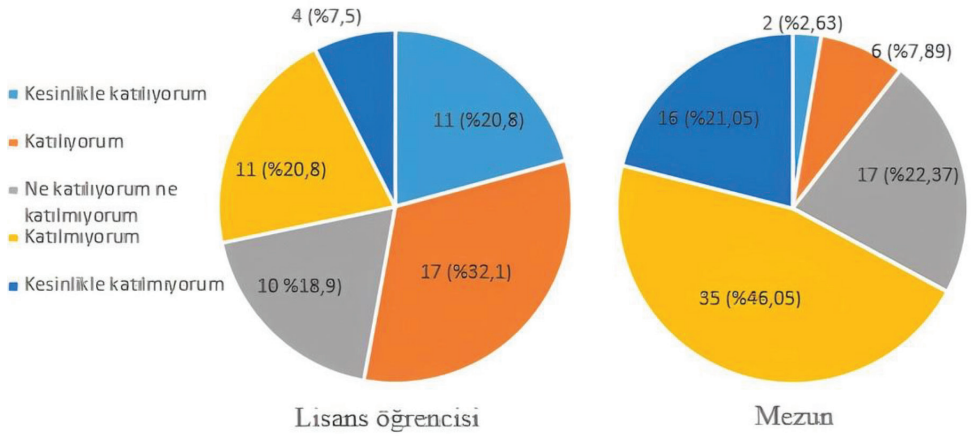
İstatistiksel Analiz

İstatistiksel analizler IBM SPSS 24.0 (SPSS Inc, Chicago, ABD) programı kullanılarak yapıldı. Nicel veriler için tanımlayıcı veriler ortalama (X), standart sapma (SS), minimum maksimum değerler ile ifade edildi. Nitel veriler ise sayı ve yüzde (n / %) olarak ifade edildi.

Çalışmamızda, önceki çalışmalara benzer şekilde, veri toplama süresi boyunca toplanan maksimum katılımcı sayısına ulaşmak hedeflenmiştir (2,6). Çalışma bitiminde mevcut katılımcı sayısı doğrultusunda G* Power 3.1.9.6. yazılımı kullanılarak post hoc ki-kare güç analizi yapılmıştır. Buna göre toplamda 129 katılımcı, etki büyüklüğü (Cohen's W)= 0,405; α= 0,05; df= 4 olarak yapılan güç analizinde çalışmanın gücü %97 olarak hesaplanmıştır.

BULGULAR

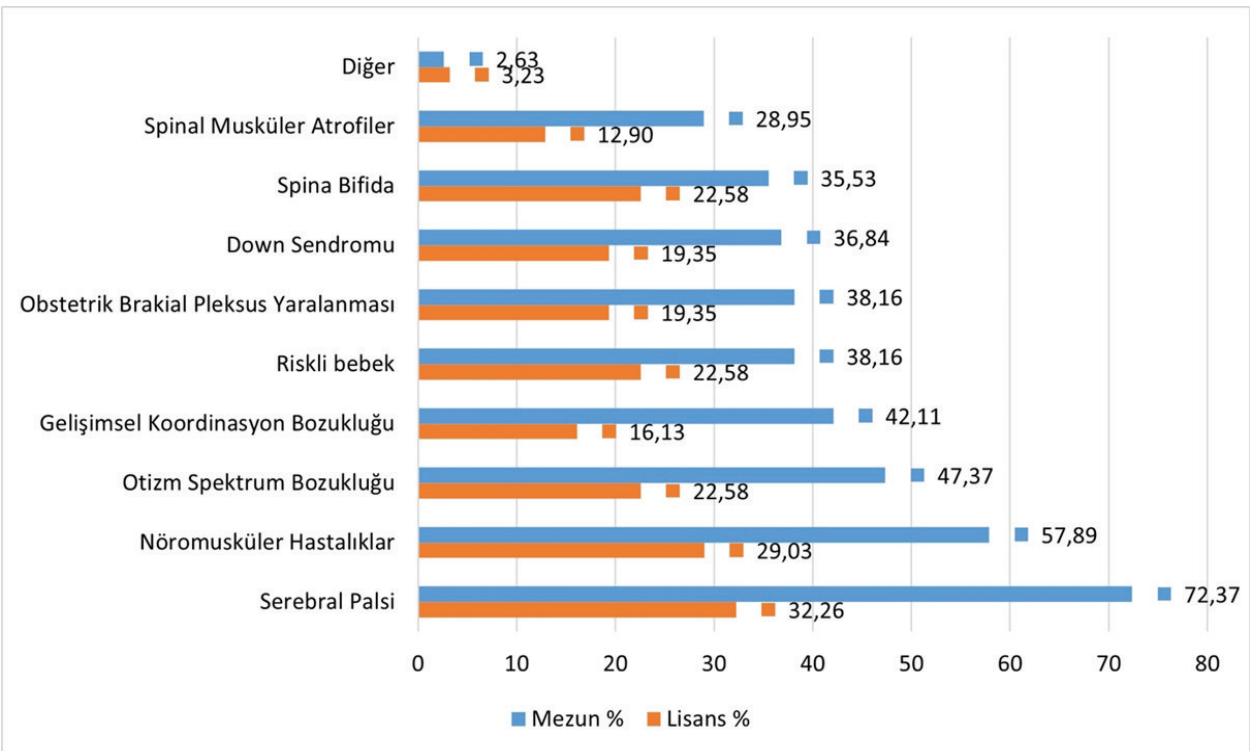
Çalışmamız kapsamında 53 lisans öğrencisi ve 76 mezuna ulaşılarak, çalışma toplamda 129 katılımcı ile tamamlandı. Çalışmaya katılan 53 lisans öğrencisi 20-26 yaş aralığında (Ort: 21,79; SS: 1.19), mezunlar ise 23-39 yaş aralığındaydı (Ort: 27,65; SS: 3,37). Lisans öğrencilerine ve mezunlara ait kişisel özellikler Tablo 1'de gösterilmiştir.



Şekil 2. "Pediatrik Rehabilitasyon Derslerinde Pratik Uygulama İmkânı Bulunan Laboratuvar Ders Saatleri Yeterlidir" İfadesine Verilen Cevapların Dağılımı

Lisans Öğrencilerinin ve Mezunların Cevaplarının İncelenmesi

Anketlerde yer alan PFTR dersinin müfredattaki dönem sayısı ve laboratuvar saatlerine ilişkin sorulara verilen cevapların dağımı Şekil-1ve Şekil-2'de verilmiştir. Buna göre, "PFTR dersinin müfredatta iki dönem olması dersin kapsayıcılığı açısından daha uygundur" sorusuna her iki gruptan da katılımcıların çoğunluğu (lisans öğrencisi: %62,26; mezun %81), 'Kesinlikle katılıyorum' ya da 'Katılıyorum' cevaplarından birini vermiştir. Dersin laboratuvar saatleri ile ilgili görüşlerin sorgulandığı "Pediatrik rehabilitasyon derslerinde pratik uygulama imkânı bulunan laboratuvar ders saatleri yeterlidir" sorusunda ise her iki gruptan da katılımcıların çoğunluğu (lisans öğrencisi: %47,17; mezun: %89,51), 'Kesinlikle katılmıyorum' ya da 'Katılmıyorum' cevaplarından birini vermiştir.



Şekil 3. Pediatrik Rehabilitasyon Ders İçeriğinde "Daha Fazla Zaman Ayırılması Gerektiği" Düşünülen Tanı Grupları

Tablo 2. Pediatrik Rehabilitasyon Dersinin İçeriğinde Yer Alması Gerektiği Düşünülen Konular

	Lisans öğrencisi n (%)	Mezun n (%)
Pediatrik romatolojik hastalıklar ve rehabilitasyonu	16 (30,18)	37 (48,68)
Pediatrik ortopedik problemler ve ortezler	19 (35,84)	63 (82,89)
Çocukluk çağı obezitesi ve fizyoterapi	10 (18,86)	18 (23,68)
Çocuklarda spor yaralamaları ve rehabilitasyonu	17 (32,07)	21 (27,63)
Riskli bebeklerde erken müdahale yöntemleri	15 (28,30)	48 (63,15)
Pediatrik kardiyak ve pulmoner hastalıklar ve rehabilitasyonu	13 (24,52)	39 (51,31)
Otizm spektrum bozukluğu ve fizyoterapi	10 (18,86)	32 (42,10)
Duyu bütünleme bozuklukları	19 (35,84)	60 (78,94)
Hiçbiri (Mevcut konular yeterlidir)	2 (3,77)	-

n: kişi sayısı; %: yüzde

PFTR dersinin içeriği ve dersin işleniş şekli ile ilişkili olan sorulara öğrenciler ve mezunlar tarafından verilen cevapların dağılımı ise Şekil-3 ve Tablo 2-3'de verilmiştir. Buna göre, "Pediatrik rehabilitasyonun kapsamına giren ve farklı derslerin içeriğinde yer alan hangi konuların PFTR dersinin içeriğinde de yer alması gerektiğini düşünüyorsunuz? (Birden çok seçenek işaretleyebilirsiniz)" sorusuna mezun grubu en yüksek oranda "pediatrik ortopedik problemler ve ortezler" seçeneğini (n=63; %82,89); lisans öğrencisi grubu ise "pediatrik ortopedik problemler ve ortezler" ve "duyu bütünleme bozuklukları" seçeneklerini eşit oranda tercih etmiştir (n=19; %35,84). Dersin işleniş şekli ile ilgili olarak anketlerde yer alan "PFTR dersinin işleniş şekillerinden hangisinin sizi dersin öğrenme hedeflerine daha iyi ulaştıracağını düşünüyorsunuz? (Birden çok seçenek işaretleyebilirsiniz)" sorusuna her iki gruptan da katılımcıların çoğunluğu "derse gerçek vakaların davet edilmesi" yanıtını (lisans öğrencisi: %45,28; mezun: %78,94), ikinci olarak da "klinik ziyaretleri" yanıtını vermiştir (lisans öğrencisi: %43,39; mezun: %72,36).

TARTIŞMA

PFTR ders içeriğini lisans öğrencileri ve mezunların bakış açısıyla incelediğimiz çalışmamız, bilgimiz dahilinde Türkiye'de bu konuda yapılan ilk çalışmadır. Çalışmamızın sonuçlarına göre, katılımcı öğrenci ve mezunların büyük çoğunluğunun PFTR ders içeriğinde yer alması gerektiğini düşündükleri konuların "pediatrik ortopedik problemler ve ortezler" ve "duyu bütünleme bozuklukları" olduğu; PFTR dersinin işleniş şekli ile ilgili de iki gruptaki katılımcıların ortak olarak "derse gerçek vakaların davet edilmesi" seçeneğini en fazla oranda tercih ettikleri görülmüştür. Ek olarak, iki gruptaki katılımcılar da PFTR dersinin müfredatta iki dönem olmasının daha uygun olacağını ve dersin laboratuvar saatlerinin yetersiz olduğunu belirtmişlerdir.

Ülkemizde PFTR dersinin içeriğine ya da dersin yapısına yönelik yapılan çalışma bulunmamasına karşın; uluslararası literatürde, özellikle ABD ve Avustralya'da yapılmış, PFTR dersinin yapı ve işleyişini geliştirmeyi amaçlayan çalışmalar ve kılavuzlar yer almaktadır (2,8–10,12). Bu konuda, Amerikan Fizik Tedavi Derneği (APTA) Pediatri Bölümü (Section on

Tablo 3. Pediatrik Rehabilitasyon Dersine Katkı Sağlayacağı Düşünülen İmkân ve Sorumluluklar

	Lisans öğrencisi n (%)	Mezun n (%)
Klinik ziyaretleri	23 (43,39)	55 (72,36)
Derse gerçek vakaların davet edilmesi	24 (45,28)	60 (78,94)
Olgu sunumları, videoları ve tartışmaları	23 (43,39)	46 (60,52)
Makale sunumu ve tartışmaları	10 (18,86)	28 (36,84)
Hiçbiri (Mevcut imkanlar yeterlidir)	2 (3,77)	-

>: büyüktür; n: kişi sayısı; %: yüzde

Pediatrics/SoP)'nün yaptığı çalışmalar dikkat çekmektedir. APTA SoP, eğitimde birliği sağlamak amacıyla giriş düzeyinde Fizik Tedavi ve Rehabilitasyon (DPT) programlarındaki pediatri içeriğine yönelik olarak 5 temel yetkinlik belirlemiştir. Bu yetkinlikler, (i) insan gelişimi, (ii) yaşa uygun hasta iletişimi ve tedavi, (iii) aile merkezli bakım, (iv) sağlığın teşviki, geliştirilmesi ve güvenliği ile (v) mevzuat, politika ve sistemleri içermektedir (10). Ek olarak, Moore ve ark. (13), ABD'de saha görüşmeleri ve anketler kullanarak yaptıkları multimetod araştırma sonucunda PFTR eğitimi için kavramsal bir model ve 4 anahtar element bildirmişlerdir. Bunlar: (i) öğretici olarak çocuk ve aile, (ii) pedagoji, (iii) örnek pediatri fakültesi ve (iv) mükemmeliyet kültürüdür. Ayrıca, APTA SoP, ABD giriş seviyesi fizyoterapi programlarına dahil edilmesi uygun görülen pediatrik tanı gruplarının da bir listesini yayınlamıştır (8).

Pediatrik Rehabilitasyon Dersinin Müfredattaki Dönem Sayısı ve Laboratuvar Saatleri

Çalışmamız dahilinde sorguladığımız konu başlıklarından biri PFTR dersinin müfredat içerisinde yer aldığı dönem sayısıydı. Hem mezunların hem de lisans öğrencilerinin çoğunluğu (lisans: %62,26; mezun: %81) dersin müfredatta iki dönem yer almasının daha uygun olacağını düşündüklerini belirtmiştir. Çalışmanın yapıldığı Haliç Üniversitesi FTR bölümünde PFTR dersi bir dönem, 14 hafta, haftada 2 teorik ve 1 laboratuvar olmak üzere dönemde 28 teorik, 14 laboratuvar saati, toplamda 42 saati olarak yer almaktadır.

Literatürde PFTR dersinin ders saatlerinin incelenip öğrenci ve öğretim elemanlarının görüşlerinin sorgulandığı çalışmalar yer almakla birlikte, ülkemizde yapılmış bir çalışmaya rastlanmamıştır. Avusturalya'daki lisans seviyesinde FTR eğitimi veren okullar ile yapılan bir anket çalışmasının sonuçlarında katılımcıların %40'ı PFTR dersi için en büyük bariyerin, mevcut ders içeriği için kısıtlı zamana sahip olunması ve öğrencilerin pediatrik popülasyon ile limitli klinik imkana sahip olması olarak belirtilmiştir (6). Schreiber ve arkadaşları (12) tarafından yapılan bir anket çalışması sonucunda, ABD'de giriş seviyesi FTR müfredatlarındaki PFTR ders içeriğindeki öğretme saatlerinin 35 ila 210 saat arasında (ortalama 99.62), teorik saatlerin 0 ila 170 saat (ortalama 44.53) ve laboratuvar saatlerinin 0 ila 126 saat (ortalama 31.8) arasında değiştiği belirtilmiştir. Çalışmaya katılanların %70'i, müfredatta pediatrik içeriği kapsayan saat sayısının yeterli olduğunu bildirmiştir. Çalışmanın sonucunda uzman görüşlerine dayanarak, fizyoterapi ve rehabilitasyon müfredatında pediatrik içeriğe toplamda 90 saat ayrılarak; vaka temelli öğrenme ve teorik ders için 60 saat, laboratuvar saatleri için ise 30 saat ayrılması önerilmiştir. Bu öneriler doğrultusunda çalışmamızın yürütüldüğü üniversitede bu saatlerin, uluslararası literatürde önerilen saatlerin oldukça altında olduğu görülmektedir.

Araştırmamızın bulgularında laboratuvar saatleri, lisans öğrencisi katılımcıların %47,17'si mezunların ise %89,51'i tarafından yetersiz bulunmuştur. ABD'de yapılan bir çalışmada profesyonel FTR eğitimi müfredatında pediatrik içeriğe ayrılan pratik uygulamaya bağlı laboratuvar saatlerinde farklılık bulunduğu ve bu saatlerinin 1990'ların başından bu yana arttığı belirtilmiştir (12).

Pediatrik Rehabilitasyon Dersinin İçeriği

Hem mezunların hem de lisans öğrencilerinin PFTR ders içeriğinde daha fazla zaman ayrılması gerektiğini düşündükleri ilk 5 tanı grubu sırasıyla serebral palsi, nöromüsküler hastalıklar, otizm spektrum bozukluğu, gelişimsel koordinasyon bozukluğu ve riskli bebek olarak belirlenmiştir.

Çalışmamızda riskli bebek tanı grubu baştan beşinci sırada yer alsa da literatürde PFTR dersi içerisinde en çok incelenen konu başlıklarından birisidir. Effgen ve ark. (14) mevcut müfredatlardaki "erken müdahale" içeriği ve kazandırdığı yetkinlikler için değişiklik yapılmasını önermiştir. Önerilen değişiklikler erken müdahale kapsamında ABD'de çocukların ev ortamında müdahale almasına imkân veren yetkiler ve terminolojideki değişikliklere (İşlevsellik, Yeti Yitimi ve Sağlığın Uluslararası Sınıflandırması (ICF)'in benimsenmesi) dayanmaktadır. Bu sebeplerle, lisans seviyesi eğitimlerdeki özellikle yenidoğan fizyoterapi ve rehabilitasyon uygulamalarının ve yeterliliklerinin genişletilmesi önerilmektedir (14). Fizyoterapi ve rehabilitasyon öğrencilerinin ve genel fizyoterapistlerin yenidoğanlar ile çalışmak için sahip olması gereken yeterliliklerin geliştirilebilmesi için, yenidoğan fizyoterapisi alanında staj ve gönüllü eğitimlere katılmaları ve bu alanda çalışan fizyoterapistlerin, acemilikten uzmanlığa

uzanan bir süreç boyunca, yaşam boyu öğrenme prensiplerince, sürekli olarak mesleki gelişim faaliyetlerini sürdürmeleri gerektiği vurgulanmaktadır (15,16).

Türkiye'den örneklere bakıldığında, FTR bölümlerindeki derslerin içeriğini araştıran bir çalışmaya rastlanmamıştır. Uzun ve ark. (17), Hacettepe Üniversitesi ergoterapi lisans programındaki dersleri öğrencilerin ve mezunların bakış açısı ile incelemiştir. Çalışmanın sonucunda, program dahilindeki derslerin mezuniyet sonrası iş hayatı ile örtüştüğü ve program içeriğinde öğrenilen bilgilerin çalışma hayatına yansıtılabildiği sonucuna varılmıştır.

PFTR ders içeriğinde yer almayıp, içeriğe dahil edilmesi gerektiği düşünülen konu başlıkları sorusuna da mezun ve öğrencilerin cevapları benzerdi. Her iki grupta da belirgin olarak en fazla verilen yanıtlar pediatrik ortopedik problemler ve ortezler ile duyu bütünleme bozuklukları olmuştur. Çalışmamızın mezun grubundaki katılımcıların PFTR alanında çalışan fizyoterapistler olması ve alanda aktif olarak gördükleri vakalara dayanarak cevap verdikleri düşünüldüğünde özellikle bu soruya mezunlar tarafından verilen cevapların kıymetli olduğu görüşündeyiz.

Pediatrik Rehabilitasyon Dersinin İşleniş Şekli

Çalışmamızda dersin işleniş şekli ile ilgili olarak sorulan "Pediatrik rehabilitasyon dersi kapsamında hangi imkân ve sorumlulukların sizi dersin öğrenme hedeflerine daha iyi ulaştıracağını düşünüyorsunuz?" sorusuna her iki grupta da en yüksek oranda verilen cevap "derse gerçek vakaların davet edilmesi" olmuştur. Literatürde yapılandırılmış ya da simülasyon hasta olarak karşımıza çıkan bu kavram APTA tarafından lisans eğitimi planlarının içerisinde yer almaktadır (18). Kenyon ve ark.'nın, ABD genelinde lisans seviyesindeki FTR eğitim programlarının müfredatında hangi pediatrik içeriğin yer alması gerektiğine dair eğitimcilerin görüşlerini inceledikleri çalışmada; eğitimciler pediatrik temel bilginin yanı sıra, tüm öğrencilerin giriş seviyesi eğitimleri sırasında tipik gelişen ve atipik gelişime sahip olan çocuklarla gerçek etkileşim fırsatına sahip olmaları gerektiğini önermişlerdir (9). ABD'de bu önerileri ele alarak PFTR dersine klinik deneyimin entegre edildiği model yaklaşımlar da uygulanmıştır (19). Avustralya'da lisans seviyesi öğrencileri ile yapılan bir çalışmada ise, PFTR dersinde simülasyon olgu uygulamasının öğrencilerin özyeterliliğine, öğrencilerin pediatrik hastaları değerlendirmesi ve hasta yönetimine anlamlı derecede katkısı olduğu belirtilmiştir (20).

Bu çalışmanın bazı limitasyonları bulunmaktadır. Birincisi, çalışma örnekleminin tek bir üniversitenin lisans öğrencilerinden ve aynı üniversitenin mezunlarından seçilmiş olması nedeniyle çalışma sonuçlarının genelleştirilemeyeceğidir. İkinci olarak, lisans öğrencileri ve mezunların yanıtlarının, anket sorularının heterojenliği nedeniyle karşılaştırılamamış olmasıdır. Gelecekte yapılacak çalışmalarda, Türkiye'deki farklı üniversitelerin öğrenci ve mezunlarının dahil edilmesi ve standardize anketlerin geliştirilmesi sonuçların genelleştirilmesi ve karşılaştırılmasına katkı sağlayacaktır.

Araştırmamız Türkiye'de PFTR dersinin içeriği, dersin işleniş şekli, ders saatlerinin yeterliliğini lisans öğrencilerinin ve mezunların bakış açısı ile sorgulayan ilk çalışmadır. Sonuçlarımız, iç paydaşlarımız olarak öğrenci ve mezunlarımızın bakış açısını yansıtmak açısından önem arz etmektedir. Uluslararası literatürde PFTR dersinin kapsamı konusunda yapılan çalışmaların tarihi göz önüne alındığında, ülkemizde bu konudaki detaylı araştırma ve müfredat geliştirme yöntemlerine olan ihtiyacın önemi anlaşılmaktadır. Bu nedenle, gelecekte benzer konularda yapılacak çalışmalar ve bu çalışmaların belirli periyodlar ile tekrar edilmesinin hem PFTR dersinin hem de genel olarak FTR müfredatlarının kalitesini arttırma açısından faydalı olacağı görüşündeyiz.

Destekleyen Kuruluş: Bulunmamaktadır.

Çıkar Çatışması: Herhangi bir çıkar çatışması bulunmamaktadır.

Yazar Katkıları: Fikir/Kavram – A.M., D.B-B.; Tasarım - A.M., D.B-B.; Danışmanlık - A.M.; Kaynaklar ve Fon Sağlanması – D.B-B.; Materyaller – D.B-B.; Veri Toplama ve İşleme – D.B-B.; Verilerin analizi ve/veya Yorumlanması - A.M., D.B-B.; Literatür Taraması – A.M.; D.B-B.; Makale Yazımı - A.M., D.B-B.; Eleştirel İnceleme - A.M.

Teşekkür: Çalışmamıza katılan tüm fizyoterapistlere ve öğrencilere teşekkür ederiz. Anket sorularına son halinin verilmesinde değerli görüş ve katkılarını sunan Sayın Dr. Öğr. Üyesi Bilge Nur Yardımcı-Lokmanoğlu'na teşekkür ederiz.

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EK-1

LİSANS ÖĞRENCİSİ ANKETİ

1. Yaşınız (lütfen yazınız)
2. Lütfen eğitim durumunuzu işaretleyiniz.
   a) 4. Sınıf öğrencisiyim ve Pediatrik Rehabilitasyon stajı yaptım
   b) 4. Sınıf öğrencisiyim, Pediatrik Rehabilitasyon stajı yapmadım
   c) 3. Sınıf öğrencisiyim ve Pediatrik Rehabilitasyon dersini aldım
   d) Pediatrik Rehabilitasyon dersini henüz almadım
3. Pediatrik Rehabilitasyon dersinin 3. Sınıfta 1(bir) dönem olarak müfredatta yer almasını ders içeriğinin kapsayıcılığı açısından yeterli buluyorum.
   a) Kesinlikle katılıyorum
   b) Katılıyorum
   c) Ne katılıyorum ne katılmıyorum
   d) Katılmıyorum
   e) Kesinlikle katılmıyorum
4. Pediatrik Rehabilitasyon dersinin 3. Sınıfta 2(iki) dönem olarak müfredatta yer almasının ders içeriğinin kapsayıcılığı açısından daha uygun olacağını düşünüyorum.
   a) Kesinlikle katılıyorum
   b) Katılıyorum
   c) Ne katılıyorum ne katılmıyorum
   d) Katılmıyorum
   e) Kesinlikle katılmıyorum
5. Pediatrik rehabilitasyon derslerinde pratik uygulama imkânı bulduğumuz laboratuvar ders saatleri yeterlidir.
   a) Kesinlikle katılıyorum
   b) Katılıyorum
   c) Ne katılıyorum ne katılmıyorum
   d) Katılmıyorum
   e) Kesinlikle katılmıyorum
6. Pediatrik Rehabilitasyon ders içeriğinde **"az zaman ayırıldığını"** düşündüğünüz bir tanı grubu varsa lütfen işaretleyiniz (birden çok seçim yapabilirsiniz).
   a) Nöromüsküler hastalıklar
   b) Serebral Palsi
   c) Riskli bebek
   d) Gelişimsel Koordinasyon Bozukluğu
   e) Otizm Spektrum Bozukluğu
   f) Spinal Musküler Atrofiler
   g) Spina Bifida
   h) Down Sendromu
   i) Doğumsal brakiyal pleksus yaralanmaları ve Tortikollis
   j) Diğer (lütfen belirtiniz)
7. Pediatrik rehabilitasyon dersinin işleniş şekillerinden hangisinin sizi dersin öğrenme hedeflerine daha iyi ulaştıracağını düşünüyorsunuz? (Birden çok seçenek işaretleyebilirsiniz)
   a) Olgu sunumları tartışmaları
   b) Derse gerçek vakaların davet edilmesi
   c) Klinik ziyaretleri
   d) Makale sunumu ve tartışmaları
   e) Hiçbiri
8. Pediatrik rehabilitasyonun kapsamına giren ve farklı derslerin içeriğinde yer alan hangi konuların pediatrik rehabilitasyon dersinin içeriği içinde de yer alması gerektiğini düşünüyorsunuz?
   a) Pediatrik romatolojik hastalıklar ve rehabilitasyonu
   b) Pediatrik ortopedik problemler ve ortezler
   c) Çocukluk çağı obezitesi ve fizyoterapi
   d) Çocuklarda spor yaralanmaları ve rehabilitasyonu
   e) Riskli bebeklerde erken müdahale yöntemleri
   f) Pediatrik kardiyak ve pulmoner hastalıklar ve rehabilitasyonu
   g) Otizm Spektrum Bozukluğu
   h) Duyu Bütünleme Bozukluğu
   i) Diğer (lütfen belirtiniz)

İKİNCİ KISIM

Lütfen aşağıdaki soruları Pediatrik Rehabilitasyon alanında bir staj tamamladıysanız yanıtlayınız.

0.1. Stajınız boyunca kaç hastanın değerlendirme ve/veya tedavisini gözlemleme şansı buldunuz? (bu soruyu şıklı hale getirdim)
a) 1-5
b) 6-10
c) 11- 15
d) 16-20
e) 20'den fazla

0.2. Stajlarda aşağıdaki tanı grupları ile karşılaştınız mı? Karşılaştıysanız hangi gruptan yaklaşık kaç hasta gördüğünüzü lütfen yanlarında belirtiniz
a) Serebral Palsi
b) Nöromusküler hastalıklar
c) Riskli bebek
d) Gelişimsel geriliği olan ancak tanı almamış çocuklar
e) Gelişimsel koordinasyon bozukluğu
f) Otizm Spektrum Bozukluğu
g) Spinal Musküler Atrofiler
h) Spina Bifida
i) Down Sendromu ve diğer genetik sendromlar
j) Doğumsal brakiyal pleksus yaralanmaları ve Tortikollis
k) Diğer (lütfen sayısı ile belirtiniz)

0.3. Stajlarda sıklıkla karşılaştığınız bu sebeple Pediatrik Rehabilitasyon ders içeriğinde **"daha çok zaman ayrılması gerektiğini"** düşündüğünüz bir tanı grubu varsa lütfen işaretleyiniz (birden çok seçim yapabilirsiniz).
a) Nöromüsküler hastalıklar
b) Serebral Palsi
c) Riskli bebek
d) Gelişimsel Koordinasyon Bozukluğu
e) Otizm Spektrum Bozukluğu
f) Spinal Musküler Atrofiler
g) Spina Bifida
h) Down Sendromu ve diğer genetik sendromlar
i) Doğumsal brakiyal pleksus yaralanmaları ve Tortikollis
j) Diğer (lütfen belirtiniz)

0.4. Mezun olduktan sonra pediatrik rehabilitasyon alanında çalışmayı düşünür müsünüz?
a) Evet
b) Hayır
c) Kararsızım

EK-2

MEZUN ANKETİ

1. Yaşınız (lütfen yazınız)
2. Lütfen eğitim durumunuzu işaretleyiniz.
   a) Lisans mezunu
   b) Yüksek lisans öğrencisi ya da mezunu
   c) Doktora öğrencisi ya da doktora mezunu
3. Lisansüstü eğitiminizi hangi alanda aldınız/almaktasınız?
   a) Lisansüstü eğitim almadım
   b) Genel Fizyoterapi ve Rehabilitasyon
   c) Pediatrik Rehabilitasyon
   d) Ortopedik Rehabilitasyon
   e) Nörolojik Rehabilitasyon
   f) Sporcu Sağlığı ve Rehabilitasyonu
   g) Kadın Sağlığı ve Rehabilitasyon
   h) Kardiyopulmoner Rehabilitasyon
   i) Diğer (lütfen belirtiniz)
4. Fizyoterapist olarak kaç yıldır çalışmaktasınız?
   a) 1 seneden az
   b) 1-5
   c) 6-10
   d) >10 sene
5. Pediatrik Rehabilitasyon alanında kaç yıldır çalışmaktasınız?
   a)1 seneden az
   b)1-5
   c)6-10
   d)>10 sene
6. Fizyoterapist olarak çalışma grubunuzun ne kadarını çocuklar oluşturmakta?
   a) Çocuklarla çalışmıyorum
   b) Sadece çocuklar ile çalışıyorum (%100)
   c) Çoğunlukla çocuklar ile çalışıyorum (%50-99)
   d) Çocuklar çalışma alanımın yarısından azını oluşturuyor (<%50)
7. Fizyoterapist olarak hangi tanı grupları ile sıklıkla çalışıyorsunuz? (birden çok seçim yapabilirsiniz)
   a) Serebral Palsi
   b) Nöromusküler hastalıklar
   c) Riskli bebek
   d) Gelişimsel geriliği olan ancak tanı almamış çocuklar
   e) Gelişimsel koordinasyon bozukluğu
   f) Otizm Spektrum bozukluğu
   g) Spinal Musküler Atrofiler
   h) Spina Bifida
   i) Down Sendromu ve diğer genetik sendromlar
   j) Doğumsal brakiyal pleksus yaralanmaları ve Tortikollis
   k) Diğer (lütfen belirtiniz)
8. Pediatrik Rehabilitasyon dersinin lisans dönemi 3. Sınıfta 1(bir) dönem olarak müfredatta yer almasını ders içeriğinin kapsayıcılığı açısından yeterli buluyorum.
   a) Kesinlikle katılıyorum
   b) Katılıyorum
   c) Ne katılıyorum ne katılmıyorum
   d) Katılmıyorum
   e) Kesinlikle katılmıyorum
9. Pediatrik Rehabilitasyon dersinin lisans dönemi 3. Sınıfta 2(iki) dönem olarak müfredatta yer almasının ders içeriğinin kapsayıcılığı açısından daha uygun olacağını düşünüyorum.
   a) Kesinlikle katılıyorum
   b) Katılıyorum
   c) Ne katılıyorum ne katılmıyorum
   d) Katılmıyorum
   e) Kesinlikle katılmıyorum
10. Pediatrik rehabilitasyon derslerinde pratik uygulama imkânı bulunan laboratuvar ders saatleri yeterlidir.
    a) Kesinlikle katılıyorum
    b) Katılıyorum
    c) Ne katılıyorum ne katılmıyorum
    d) Katılmıyorum
    e) Kesinlikle katılmıyorum

11. Lisans eğitimi dahilindeki Pediatrik Rehabilitasyon dersi mezuniyet sonrası çalışma hayatım için yeterli bilgi ve beceri birikimini sağlamıştır.
    a) Kesinlikle katılıyorum
    b) Katılıyorum
    c) Ne katılıyorum ne katılmıyorum
    d) Katılmıyorum
    e) Kesinlikle katılıyorum
12. Mezuniyet sonrası, pediatrik rehabilitasyon alanında düzenlenen eğitim ve kurslara katıldınız mı? Katıldıysanız lütfen açıklamada kursları belirtiniz.
    a) Mezuniyet sonrası kurslara katılmadım
    b) Mezuniyet sonrası kurslara katıldım (kursları belirtiniz)
13. Fizyoterapist olarak sıklıkla karşılaştığınız ve lisans döneminde Pediatrik Rehabilitasyon ders içeriğinde "daha çok zaman ayırılması gerektiğini" düşündüğünüz bir tanı grubu varsa lütfen işaretleyiniz (birden çok seçim yapabilirsiniz).
    a) Nöromüsküler hastalıklar
    b) Serebral Palsi
    c) Riskli bebek
    d) Gelişimsel Koordinasyon Bozukluğu
    e) Otizm Spektrum Bozukluğu
    f) Spinal Musküler Atrofiler
    g) Spina Bifida
    h) Down Sendromu ve diğer genetik sendromlar
    i) Doğumsal brakiyal pleksus yaralanmaları ve Tortikollis
    j) Diğer (lütfen belirtiniz)
14. Pediatrik rehabilitasyon dersi kapsamında hangi ek imkân ve sorumluluklar yer almış olsaydı, mesleki hayatınız için dersin sağladığı katkının artacağını düşünüyorsunuz?
    a) Klinik ziyaretleri
    b) Olgu sunumları, videoları ve tartışmaları
    c) Makale sunumu ve tartışmaları
    d) Derse gerçek vakaların davet edilmesi
    e) Hiçbiri
15. Pediatrik rehabilitasyonun kapsamına giren ve farklı derslerin içeriğinde yer alan hangi konuların pediatrik rehabilitasyon dersinin içeriği içinde de yer alması gerektiğini düşünüyorsunuz?
    a) Pediatrik romatolojik hastalıklar ve rehabilitasyonu
    b) Pediatrik ortopedik problemler ve ortezler
    c) Çocukluk çağı obezitesi ve fizyoterapi
    d) Çocuklarda spor yaralanmaları ve rehabilitasyonu
    e) Riskli bebeklerde erken müdahale yöntemleri
    f) Pediatrik kardiyak ve pulmoner hastalıklar ve rehabilitasyonu
    g) Otizm Spektrum Bozukluğu
    h) Duyu Bütünleme Bozukluğu
    i) Diğer (lütfen belirtiniz)

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INSTRUMENT ASSISTED SOFT TISSUE MOBILIZATION IN MANAGEMENT OF ATHLETIC AND MUSCULOSKELETAL CONDITIONS: A SYSTEMATIC REVIEW AND META-ANALYSIS

SYSTEMATIC REVIEW

ABSTRACT

Purpose: Instrument assisted soft tissue mobilization (IASTM) is a therapeutic intervention that involves the use of specialized tools to manipulate the muscles, tendons, myofascia and skin in a variety of soft tissue problems. Nonetheless, there is a divergence of opinions when it comes to the efficacy of IASTM in the treatment of athletic and musculoskeletal conditions. This systematic review was conducted to evaluate the effectiveness of IASTM in management of athletic and musculoskeletal conditions.

Methods: An investigation of the literature was carried out from inception to April 2023 using the databases PubMed, PEDro, and the Cochrane Library.

Results: Eighteen studies were included for qualitative synthesis, and six were selected for further quantitative synthesis. The effectiveness of IASTM in the management of athletic and musculoskeletal conditions was found to be either better or equal in comparison to other control interventions. The meta-analysis results showed that the reduction in pain was statistically significant in the experimental group (IASTM) compared to the control group (MD -1.33, 95% CI [-1.59, -1.06], $p < 0.0001$).

Conclusion: It can be stated that IASTM is an effective tool in the management of athletic and musculoskeletal conditions. Further studies should concentrate on investigating the efficiency of EASTM on particular participants with various specific athletic and musculoskeletal conditions.

Keywords: Athletic Performance, Musculoskeletal Manipulations, Musculoskeletal Pain, Myofascial Pain Syndrome

ATLETİK VE MUSKULOSKELETAL DURUMLARIN YÖNETİMİNDE ALET DESTEKLİ YUMUŞAK DOKU MOBİLİZASYONU: SİSTEMATİK DERLEME VE META-ANALİZ

SİSTEMATİK DERLEME

ÖZ

Amaç: Alet destekli yumuşak doku mobilizasyonu (IASTM), çeşitli yumuşak doku problemlerinde kasları, tendonları, miyofasyayı ve cildi manipüle etmek için özel aletlerin kullanılmasını içeren terapötik bir müdahaledir. Bununla birlikte, atletik ve kas-iskelet sistemi rahatsızlıklarının tedavisinde IASTM'nin etkinliği söz konusu olduğunda görüş ayrılığı vardır. Bu sistematik derleme, atletik ve kas-iskelet sistemi rahatsızlıklarının yönetiminde IASTM'nin etkinliğini değerlendirmek amacıyla yapılmıştır.

Yöntem: Bu çalışma, kuruluşlarından Nisan2023 tarihine kadar PubMed, PEDro ve Cochrane Library veritabanlarında yayımlanmış olan literatür incelenerek gerçekleştirildi.

Sonuçlar: Nitel senteze 18 çalışma dahil edildi ve bunların altısı daha ileri nicel sentez için seçildi. IASTM'nin atletik ve kas-iskelet sistemi durumlarının yönetimindeki etkinliği, diğer kontrol girişimlerininkine benzer veya daha iyi bulundu. Meta-analiz sonuçları, deney grubunda (IASTM) ağrının kontrol grubuna kıyasla istatistiksel olarak anlamlı şekilde daha fazla azaldığını gösterdi (MD -1.33,% 95 CI [-1.59, -1.06], $p < 0.0001$).

Tartışma: IASTM'nin atletik ve kas-iskelet sistemi rahatsızlıklarının yönetiminde etkili bir araç olduğu söylenebilir. İleriki çalışmalar, EASTM'nin çeşitli spesifik atletik ve kas-iskelet sistemi rahatsızlıkları olan belirli katılımcılar üzerindeki etkinliğini araştırmaya yoğunlaşmalıdır.

AnahtarKelimeler: Atletik Performans, Kas-İskelet Manipülasyonları, Kas-İskelet Ağrısı, Miyofasiyal Ağrı Sendromu

INTRODUCTION

Instrument assisted soft tissue mobilization (IASTM), coined by James Cyriax, is a popular treatment that involves the use of specialized tools to manipulate muscles, tendons, myofascia, and skin (1,2). IASTM helps therapists evaluate and mobilize soft tissue using tools applied in multiple directions and kept on the skin at various angles ranging from 30 to 60 degrees (3,4). IASTM tools are specifically crafted implements used for soft tissue mobilization, such as addressing myofascial adhesion and scar tissue, with the goal of easing discomfort and enhancing function and range of motion (4). The use of these tools is said to benefit physiotherapists mechanically by allowing more precise therapy and deeper penetration, thereby reducing stress on the hands (6,7). Both the therapist and the patient believe that employing instruments for soft tissue mobilization will improve vibration sensitivity, making it easier for the patient to detect modified sensations within the intervening tissues, which can assist the therapist in identifying changes in tissue qualities (8).

It is believed that IASTM therapy encourages collagen regrowth and repair by attracting fibroblasts and stimulates connective tissue remodeling by facilitating the absorption of excess fibrosis (9,10). Consequently, scar tissue, adhesions, and fascial limitations are released and broken down (11). In rat models of enzyme-induced tendinitis, the use of instruments resulted in increased fibroblast proliferation and collagen repair (12,13). This study contributes to the growing evidence that instrument massage significantly enhances ligament strength and stiffness over time (e.g., four weeks) when compared to the contralateral control limb. Many of these benefits were also observed in a laboratory study on ligament healing in rats (14). While these results offer early evidence that IASTM can induce connective tissue remodeling, further research is needed to confirm these physiological changes in human trials.. A latest systematic review with meta-analysis is necessary to overcome the limitations of previous research on IASTM. While Cheatham et al. identified short-term improvements in joint range of motion (ROM) with IASTM, overall evidence supporting its efficacy for treating common musculoskeletal pathologies remains limited (1). Seffrin et al. reported IASTM effective in enhancing ROM and improving pain and function, but highlighted the need for more extensive research involving diverse patient populations (38). Nazari et al. noted potential short-term benefits of IASTM but found inconclusive evidence for long-term pain relief and functional improvement (39). Therefore, a new comprehensive systematic review with meta-analysis with a larger number of studies could provide more robust evidence on effectiveness of IASTM, informing optimal treatment protocols and clinical practice guidelines for managing athletic and musculoskeletal conditions. To achieve this, a systematic review and meta-analysis were conducted.

METHODS

Eligibility Criteria

The present systematic review was designed and conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) guidelines (Figure 1.)(15).This review was also registered in PROSPERO as CRD 42023410985 on 04 April 2023. All the randomized controlled trials published from Inception to April 2023 in English were taken in this study. Articles using IASTM as a treatment either alone or in combination with other interventions were taken.

Information Source

Electronic databases were used in the search such as Cochrane Library, PubMed and PEDro were searched in April, 2023 to locate the articles.

Search Strategy

The search term “IASTM” or “Instrument Assisted Soft Tissue Mobilization”, combined using advanced searched option along with Boolean Operators (‘AND’ and ‘OR’) with similar keywords and filters followed, utilize in orders like: title/abstract; Randomized Controlled Trials and duration (Inception to April 2023) to find the articles. The PICO strategy involved considering the population as participants who underwent IASTM, the intervention being the application of IASTM treatment. The outcome variables assessed included pain measured through VAS or NRS, as well as measures

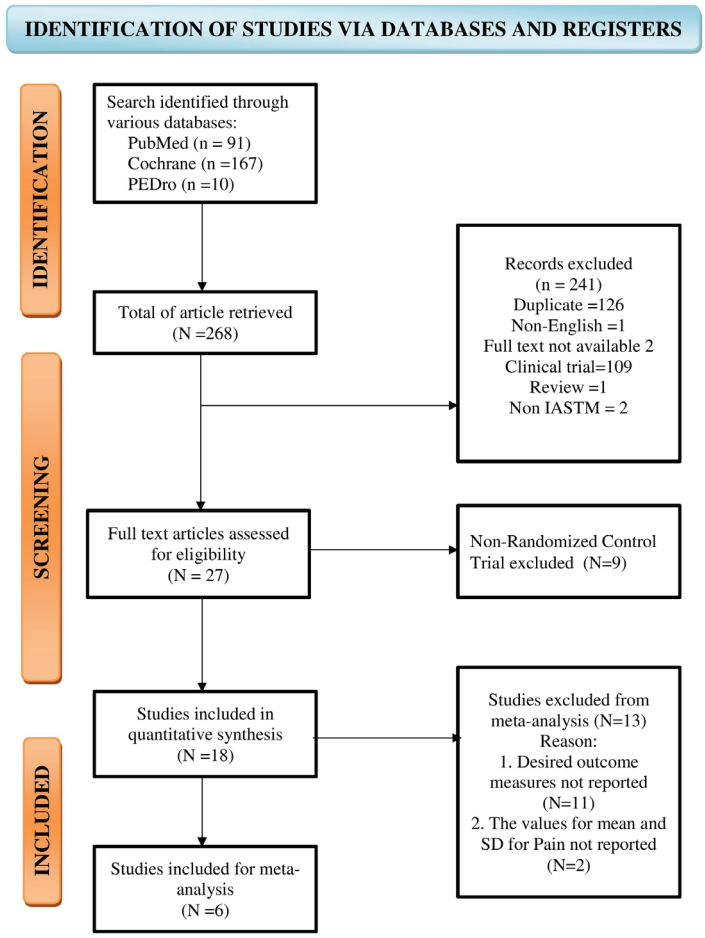

Figure 1. Prisma Flow Chart

of range of motion (ROM), strength, power, endurance, pressure pain threshold (PPT), and disability.

Study Selection

The studies were initially examined by title and abstract, then by the presence of full-text articles. 18 studies were chosen and included in this systematic review after the duplicates were eliminated and the inclusion criteria were followed. The criteria for inclusion were: Studies that were randomized controlled trials, studies in which use of IASTM as intervention either alone or in combination with other intervention, on human participant and in English language were selected. For meta-analysis, studies with the available values of mean and standard deviation for the variable pain were included.

Data Collection Process

Three reviewers (AM, SJ and RC) separately searched using the MeSH term and associated keywords selected, retrieved the data and evaluated the quality of the included studies using PEDro (The Physiotherapy evidence database). Any disagreements were settled by conversation with the author (SJ), and SJ's judgment was taken as final.

Data Extraction

Three reviewers (AM, SJ and RC) extracted the data from the potential articles. The mean and standard deviation for the variable pain (measured by VAS or NPRS) as well as details from each trial, such as the study ID (first author and year), study location, duration, sample size, intervention, outcome measures, and results, were extracted from the studies. Table 1. shows the characteristics of the studies included.

Risk Bias in Studies

By using the Physiotherapy Evidence Database (PEDro), the studies' methodological quality was

Table 1. Showing the Characteristics and Findings of Included Studies.

Study	Design	Sample	Intervention	Outcome Variables	Results
Mylonas et al. (2021)	Randomized control trial	20 female patients with mechanical neck pain lasting over 3 months.	**Group A** (N=10) IASTM for 10 min, 8 session. **Group B** (N=10) Massage for 10 min, 8 session.	• Cranio-vertebral angle • Cervical ROM • Strength • VAS • NDI Assessed at baseline, throughout the treatment period, week 2 and 4 post treatment.	Both groups showed improvement in CROM, strength and pain. Greater improvement in CVA and NDI in Group A than in group B.
Gulick (2017)	Randomized control trial	36 healthy participants having knots in neck region.	**Group A** (N=16) Six IASTM session for 5 min, over 3 weeks of interval using 3 IASTM techniques. **Group B** (N=20) Control group, no treatment.	• Pain pressure threshold Initial day and three weeks later.	Improvement in in PPT on myofascial trigger points in IASTM group when compared to control group.
Stanek et al. (2018)	Randomized control trial	44 physically active people with less than 30-degree dorsiflexion.	**Group A** (N=18) Compressive myofascial release applied for 1 min. **Group B** (N=17) Garston technique applied for 1 min. **Group C** (N=18) Control group lying for 5 min.	• Ankle-dorsiflexion Before and immediately after treatment.	Improvement in dorsiflexion in CMR group as compared to GT and control group.
Stroiney et al. (2020)	Randomized controlled trial	49 collegiate recreational athletes	**Group A** (N=25) IASTM for a maximum of 90 sec. **Group B** (N=24) Self-myofascial release for a maximum of 90 sec.	• Pain • Vertical and horizontal power • Sprinting performance	No significant difference in pain, both groups did not improved sprinting performance. Self-myofascial release prior to exercise improve jump height.
Kim et al. (2018)	Randomized controlled trial	40 young soccer players	**Group A** (N=20) IASTM for 60 min, 5 session, per week for 12 weeks. **Group B** (N=20) Control groups No intervention.	• Isokinetic power • Fatigue • Physical fitness After 1 week post treatment.	Increase in performance and fitness and decrease in fatigue in IASTM group as compared to control group.
Ikeda et al. (2019)	Randomized controlled crossover study	14 healthy volunteers	**Group A** IASTM 5 min. **Group B** Control group No intervention.	• Ankle-dorsiflexion ROM • Peak passive torque • Ankle joint stiffness • Muscle stiffness Assessed before and immediately after the intervention.	IASTM group showed improvement in dorsiflexion ROM and decrease in ankle joint stiffness and no change in peak passive torque and muscle stiffness when compared to control group.
Gunn et al. (2019)	Randomized clinical trial	40 non-disabled adults	**Group A** (N=17) IASTM with static stretching. **Group B** (N=23) PNF with static stretching. Stretch for 30 sec, Repeated for 4 repetitions.	• Hip flexion ROM •Active straight leg Raise Assessed at pre and post interventions.	Both interventions resulted in greater increase in hip flexion range.
Garcia et al. (2021)	Randomized controlled trial	21 regulars cross-fitters	**Group A** (N=11) Stretching, isometric contraction and IASTM. **Group B** (N=10) IASTM only 2 days a week for 4 weeks.	• Shoulder range of motion Assessed prior to intervention, following intervention, and after a 4-week follow-up period.	Both groups yields the similar results.
Mahmood et al. (2021)	Randomized controlled trial	60 Male patients, 18-40years upper crossed syndrome	**Group A** (N=30) Routine physical therapy. **Group B** (N=30) IASTM along with Routine physical therapy. Thrice a week for 4 weeks.	• Pain •ROM Baseline, after 2 weeks & 4 weeks	IASTM along with RPT group was found to be more effective when compared to routine physical therapy group.

Kim et al. (2021)	Randomized controlled trial	32 participants with chronic low back pain	**Group A** (N=16) TENS and IASTM for 6 min twice a week for 3 weeks. **Group B** (N=16) Control group no treatment.	•Pain •Disability •Passive straight leg raise •Supine bridge test Baseline After 3 weeks intervention.	TENS and IASTM group showed significant improvement in pain and motor function when compared to control group.
Schaefer et al. (2012)	Randomized controlled trial	36 healthy physically active individuals with chronic ankle instability	**Group A** (N=11) DBT **Group B** (N=13) DBT and GISTM-Sham **Group C** (N=13) DBT and GISTM Twice a week, 8 min for 4-week period.	• Foot and ankle ability measure • Activities of daily living • Visual analog scale • Ankle ROM • Star excursion balanced test After four weeks of intervention.	Improvement in all groups in outcome variable except in VAS. Largest effect was found in most outcome variables in the DBT/GISTM group.
Jones et al. (2019)	Randomized controlled study	11 participants with chronic plantar heel pain	**Group A** (N=5) IASTM and Exercise twice weekly for the 4 weeks for a total of 8 treatment sessions. **Group B** (N=6) Exercise for 20 min.	• Pain • Function Assessed at baseline, after final treatment, and 90 days later.	Both groups demonstrate improvement in pain but IASTM and Exercise group shows better results as compared to only exercise group.
Laudner et al. (2014)	Randomized controlled trial	35 Asymptomatic collegiate baseball players	**Group A** (N=17) IASTM for 40 secs. **Group B** (N=18) Control group- no treatment.	• Passive glenohumeral horizontal adduction and internal rotation ROM Assessed at pre and post test	IASTM group having greater improvements compared to the control group ($p<0.001$).
MacDonald et al. (2016)	Randomized controlled trial	48 physically active adults	**Group A** (N=16) IASTM for 3min. **Group B** (N=16) Control group no treatment.	• Vertical jump height • Peak power • Peak velocity Assessed at Pre and post test	No statistically significant differences found between treatment groups.
Kumar et al. (2020)	Randomized control study	34 subjects were with cervicogenic headache	**Group A** (N=17) Suboccipital release, MFR with IASTM **Group B** (N=17) Suboccipital release, MFR Both group exercises for 40 secs Twelve sessions, 3 sessions a week to both groups 15 repetitions each (twice a day).	• Visual analog scale • Headache intensity • Cervical rotation test • Cervical ROM	Between group comparison showed no significant improvement in any outcome variables but showed clinical significant in pain, ROM headache intensity and CFR in both the group.
Osalian et al. (2021)	Randomized controlled trial	23 young non-athletic college students with unilateral hamstring tightness	**Group A** (N=12) IASTM for 2 minutes. **Group B** (N=11) Manual stretching for 3 minutes.	• Hip flexion • Torque • Power Before After intervention	IASTM was as good as manual stretching in the improving the outcome variables.
Kim et al. (2019)	Randomized clinical trial	16 healthy male college students	**Group A** (N=8) IASTM was applied for 8 min. **Group B** (N=8) Control- no intervention	• Maximal isometric strength • Muscle soreness • Creatine kinase activity immediately and 48 hr. after exercise.	Recovery of maximal isometric strength was faster in IASTM group than control group.
Mostafa et al. (2022)	Randomly controlled trial	30 patients with mechanical neck pain	**Group A** (N=15) IASTM and conventional treatment **Group B** (N=15) Conventional treatment 3 times a week for 4 weeks.	• Visual analogue scale • Neck disability index • ROM Baseline at the end of study	IASTM that was more effective than conventional treatment group in relieving pain, functional disability and ROM.

ROM : Range of motion, VAS : Visual analog scale, NDI : Neck disability index, CROM : Cervical range of motion, CVA : Craniovertebral angle, CMR : Compressive myofascial release, GT : Graston technique, RPT : Routine physical therapy, TENS : Transcutaneous electrical nerve stimulation, DBT : Dynamic balance training, GISTM : Graston instrument soft tissue mobilization, MFR : Myofascial release, CFR : Cervical flexion rotation.

evaluated. When studies met the standards for intention to treat analysis, assessor blinding, and randomization and allocation concealment, they were deemed to be of high quality. The risk assessment for determining the risk of bias in the included research was conducted using the Robvis (visualization tool). The quality assessment was done by two authors independently (AM, SJ).

Statistical Analysis

The statistical analysis for this study was conducted using Review Manager 5.4 (RevMan 5.4), a software tool developed by the Cochrane group specifically designed for systematic reviews and meta-analyses. This software allows researchers to effectively synthesize and analyze data from various studies by inputting key statistical parameters

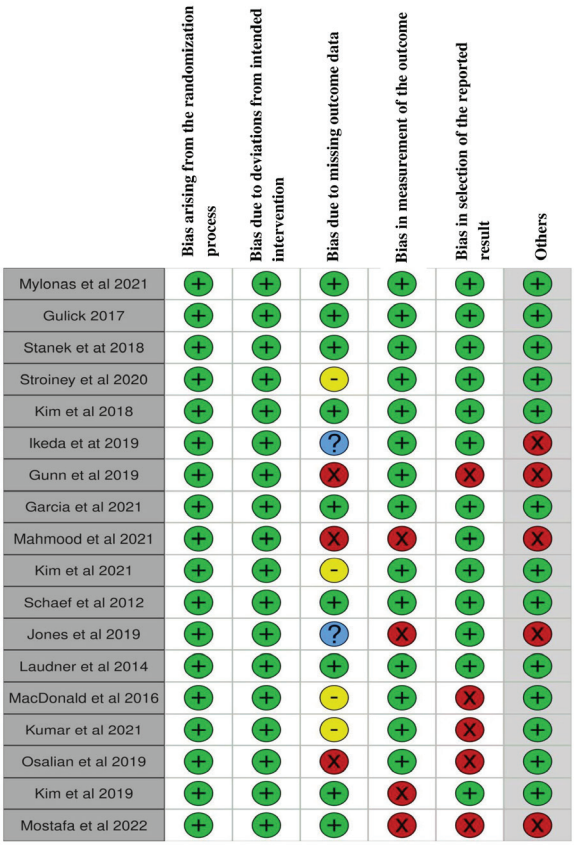

Figure 2. Shows the Summary of Risk of Bias

such as standard deviation, mean, and total participant numbers for each variable of interest, in this case, the pain variable. By computing the mean difference (MD) and 95% confidence interval (95% CI), researchers can assess the significance of the observed effects between intervention and control groups. The results are then visualized using a forest plot, which provides a graphical representation of the data, aiding in the interpretation of the findings. It's worth noting that the statistical significance level was set at $p<0.05$, ensuring that only results with a high degree of certainty are considered significant. Moreover, to enhance the reliability of the analysis, the meta-analysis process was conducted independently by two authors (RC, AM), minimizing the risk of bias and errors. This study utilized Review Manager 5.4 (RevMan 5.4), version 5.4.1, released on November 18, 2020, which is developed and maintained by the Cochrane Editorial and Methods Department, affiliated with Cochrane, and headquartered in Copenhagen, Denmark.

RESULTS

Study Selection

A total of 268 articles were identified from the search engines PubMed (N= 91), Cochrane (N=167) and Pedro (N= 10) by utilizing the above keywords. The title and then the abstract of every study were read before selection. 18 studies were chosen for the systematic review after screening, according to the inclusion criteria, and eliminating duplicates. A total of 250 articles were excluded due to duplication or not meeting the inclusion criteria. The search strategy's summary and the explanations for manuscript exclusion are provided Figure 1. PRISMA flow chart.

Study Characteristics

Out of 18 studies,8 studies were from USA (16-23),3 studies were from Korea (24-26),1 study was from Egypt (27),1 from Spain (28),1 from Japan (29),1 from India [30],1 from Saudi Arabia (31),1 from Greece (32), 1 from Pakistan (33).

Table 2. Showing the Assessment of Quality of Studies by Pedro Scoring

Study	1	2	3	4	5	6	7	8	9	10	11	Total
Mylonas et al. (2021)	0	1	0	1	0	0	1	1	0	1	1	6/10
Gulick et al. (2017)	1	1	0	0	0	0	0	0	0	1	1	4/10
Stanek et al. (2018)	0	1	0	0	0	0	1	1	0	1	1	5/10
Stroiney et al. (2020)	1	1	0	1	0	0	0	0	0	1	1	5/10
Kim et al. (2018)	1	1	0	1	0	0	1	0	1	1	1	7/10
Ikeda et al. (2019)	1	1	0	0	0	0	0	1	1	1	1	6/10
Gunn et al. (2019)	1	1	1	0	0	0	1	0	0	1	1	6/10
Garcia et al. (2021)	1	1	1	1	0	0	1	1	1	1	1	9/10
Mahmood et al. (2021)	1	1	0	1	0	0	1	1	0	1	1	7/10
Kim et al. (2021)	0	1	0	1	0	0	0	0	0	1	1	4/10
Schaefer et al. (2012)	1	1	1	1	0	0	0	0	0	1	1	6/10
Jones et al. (2019)	1	1	1	0	0	0	1	0	0	1	1	5/10
Launder et al. (2014)	1	1	0	1	1	0	0	1	0	1	1	7/10
MacDonald et al. (2016)	1	1	0	1	1	0	0	1	0	1	1	7/10
Kumar et al. (2020)	1	1	0	1	0	0	0	1	0	1	1	6/10
Osailan et al. (2021)	1	1	0	1	1	0	0	0	0	1	1	6/10
Kim et al. (2019)	0	1	0	1	0	0	0	0	0	1	1	4/10
Mostafa et al. (2022)	1	1	0	0	0	0	0	1	0	1	1	5/10

PEDro scale: 1, eligibility criteria; 2, random allocation; 3, concealed allocation; 4, similarity at baseline; 5, blinding of participants; 6, blinding of therapists; 7, blinding of assessors; 8, measures of at least one key outcome from at least 85% of participants initially allocated to groups; 9, intention to treat analysis; 10, between-group comparison; 11, point measures and measures of variability. 1: Yes (1 point), 0: No (0 point), maximum score: 10.

The qualities of the studies mentioned are in Table 2. In 18 studies, one study (28) had Pedro score of 9 out of 11, three studies (16,25,26) had Pedro score of 4 out of 11, four studies (17,18,21,27) had Pedro of 5 out of 11, four studies (22-24,33) had Pedro of 7 out of 11, and six studies(19,20,29-32) had Pedro of 6 out of 11.

Risk of Bias

Figure 2. provides a summary of the risk of bias. 18 studies in all were included, out of those 18 studies showed low risk due to randomization, 18 studies showed low risk due to deviation from intended intervention. 4 studies had high risk of bias in measurement of outcome,3 studies had high risk of bias due to missing outcome data, 5 studies had high risk of bias in selection of reported result, 4 studies had some concern of bias due to missing of outcome data, 2 studies had no information regarding outcome data, 14 studies showed low risk of bias in overall. All of the included studies had a low overall risk of bias. Figure 2 showing Risk of Bias Summary of the Included Studies.

Effect of IASTM on Pain

The data on pain was extracted from six randomized controlled trials including a total of 88 participants. The meta-analysis results displayed that the reduction in pain was statistically significant for the experimental group (IASTM) as compared to the control group (MD-1.33, 95% CI[-1.59,-1.06], p<0.0001.Figure 3 shows the forest plot for the variable pain between the intervention and control group.

In the present review eight studies have explored the role of IASTM on pain in various musculoskeletal conditions. Out of the studies included six studies showed reduction in pain intensity with the application of IASTM (20,21,25,27,32,33) Whereas, one study has shown no significant difference in perceived pain and performance in recreational collegiate athletes (18). Another study also showed no significant improvement in pain with the application of IASTM in combination with suboccipital release and myofascial release in patients with cervicogenic headache, but the improvements were clinically significant (33).

Effect of IASTM on Range of Motion

In the present review, eleven studies have explained the effect of IASTM on range of motion at various joints (17,19,20,22,27-33) Out of these, three studies have explored the role of IASTM on cervical range of motion (CROM) and out of these two studies has shown significant improvement in CROM (27,32) whereas, one study has shown no

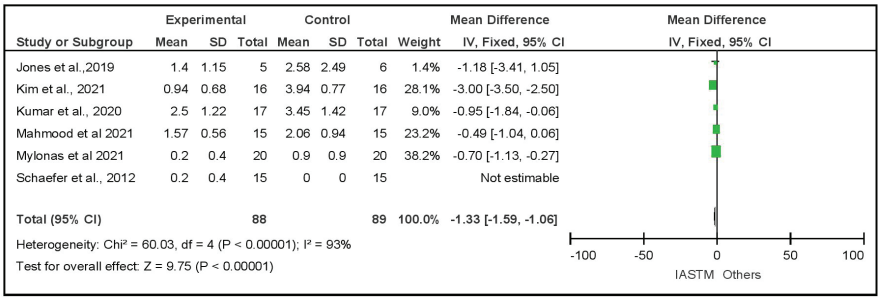

Figure 3. Shows the Gorest Plot for Pain between the Intervention and Control Group

statistically significant improvement in cervical ROM but the improvement were found to be clinically significant (30). Three studies have explored the effect of IASTM and showed improvement in range of motion at the ankle joint (17,20,29).Three studies on shoulder joint and out of these, two studies showed significant improvement in internal rotation and horizontal adduction at shoulder joint with the application of IASTM (22,33) and one study showed similar improvement in ROM with the application of IASTM alone or with the combination of stretching and isometric contraction and IASTM at the shoulder joint internal rotation and horizontal adduction (28). Two studies showed significant improvement in ROM at the hip joint ROM with the application of IASTM (19,31).

Effect of IASTM on Strength

The studies that were examined in this review also looked at how IASTM affected strength. Two studies have explored the effect of IASTM on strength. One study suggests that the recovery of maximal isometric strength was faster in IASTM group as compared to the control group (26) and another study showed that and showed improvement in the muscle strength as compared to control group (32).

Effect of IASTM on Power and Endurance

The effect of IASTM on power was explored in four studies in the present review. Two out of the four studies included showed no improvement in power (18,23) whereas, two studies (24,31) reported improvement in power in the group treated with IASTM. One study has explored the effect of IASTM on muscle endurance that showed significant improvement when IASTM is applied in combination with TENS in patients with chronic low back pain (25).

Effect of IASTM on PPT

One study in the present review explored the effect of IASTM on pain pressure threshold (PPT) that showed improvement in the PPT in healthy participants (16).

Effect of IASTM on Disability

The review includes five studies, explored the IASTM's effect on disability. Out of which, four studies have shown significant improvement in disability (20,25,27,32) whereas, one study showed no statistically significant improvement in disability but the improvements were clinically significant (30).

The result of the study revealed that the use of IASTM used in isolation or with other interventions was effective tool in improving the various outcome measures such as pain, range of motion, strength, pain pressure threshold, power and endurance.

DISCUSSION

The purpose of this review is to provide an overview on the effectiveness of IASTM on various outcome measures. The result of the systematic review suggests that the use of IASTM was effective on various outcome measures. The results of the meta-analysis on the variable pain revealed a statistically significant reduction in the pain in the interventional group treated with IASTM as compared to the control group (MD= -1.33, p<0.0001).

In the present review out of eight studies, six studies showed reduction in pain intensity with the application of IASTM (20,21,25,27,32,33).Whereas, one study showed no significant difference in perceived pain (18) and another reported no significant improvement in pain with the use of IASTM in combination with suboccipital release and myofas-

cial release in patients with cervicogenic headache (33). The possible mechanism for reduction in pain could be increased blood flow with the application of IASTM. Increase in blood flow removes pain producing substances and can reduce swelling that is developed around any injured structure (34). Another author has suggested increase in perfusion with the application of IASTM (35). Pain is mainly caused by inflammation of the injured tissues and application of IASTM may control the inflammation by break down the fascial restrictions and scar tissue Local inflammation is stimulated by the application of controlled microtrauma to the afflicted soft tissue structure. Microtrauma starts the process of reabsorbing unneeded fibrosis or excessive scar tissue, facilitates a series of healing processes that lead to the remodeling of the soft tissue structures that are impacted, and can even control the inflammatory processes. But this theory warrants further investigations as various previous studies could not appropriately suggest the effect of IASTM on inflammatory responses. Thus, possibly the increase in circulation and mobility of soft tissue can be taken as prospective mechanism for pain reduction with the use of IASTM.

A systematic review on Instrument Assisted Soft Tissue Mobilization (IASTM) efficacy for musculoskeletal conditions and joint range of motion (ROM) using seven randomized controlled trials. While some short-term improvements in joint ROM were observed, overall, evidence supporting its efficacy for treating common musculoskeletal pathologies remains limited (1). Another systematic review on Instrument-Assisted Soft Tissue Mobilization (IASTM) indicating its effectiveness in enhancing range of motion for uninjured individuals and improving pain and patient-reported function in injured patients. While supportive, the study emphasizes the need for more extensive research involving diverse patient populations and products to generalize these findings (38). Another systematic review with meta-analyses assessing the effectiveness of IASTM for upper body, lower body, and spinal conditions. The study suggests potential benefits of IASTM, particularly in short-term improvement of joint range of motion. However, evidence for long-term pain relief, range of motion enhancement, or functional improvement remains inconclusive (39).The present review also suggests of increase in range of motion with the application of IASTM. Out of the eleven studies that have explored the effect of IASTM on range of motion at various joints (17,19,20,22,27-33).Nine studies reported IASTM as an effective intervention for improving ROM at various joints (17,19,20,22,27,29,31-33).One study has shown no statistically significant improvement in cervical ROM but the improvement was clinically significant (30). Another study displayed similar improvement in ROM with the application of IASTM alone or used with the combination of stretching and isometric contraction at the shoulder joint (28). Studies have explained the improvement in range of motion can be because of the two mechanisms. First one is that the application of IASTM produces heat by the frictional forces to the connective tissues. This heat decreases the viscosity of the tissues and thereby increases the extensibility and reduces the restrictions in the tissues and the decrease in the viscosity of tissues increases the ROM (36). Similar recommendations were proposed by another study that also suggests that the application of mechanical stress, heat, massage or pressure is to the fascia makes it more pliable thereby allowing a greater ROM (25). Another mechanism is that the application of mechanical stress on the muscle fascia stimulates the intra fascial mechanoreceptors which modulates the proprioceptive inputs to the CNS which in turn alters the tension in the motor units of the tissues producing increase in the ROM (37). A study indicates that IASTM may result in side effects such as bruising, inflammation, and muscle soreness. Post-treatment, certain patients reported sensations of warmth or tingling, while less frequent risks included skin redness and increased pain (37).In addition to this the present study also advocates the use of IASTM in improving the strength, endurance and improving the disability. Two studies included in the review have explored the effect of IASTM on muscle strength and both the studies suggested an increase in the muscle strength as compared to control group (26,32).One study has explored the effect of IASTM on muscle endurance that showed significant improvement when IASTM is applied in combination with TENS in patients with chronic low back pain (25). The possible reasons for results may be attributable to strong muscle contractions that are

made possible by releasing restrictions in the soft tissues, which may have boosted muscle strength and endurance (24). Out of the four studies on estimating the effect of IASTM on power, two suggests improvement in the power as the use of IASTM can aid in tissue fluid exchange, boost oxygen delivery to soft tissues to lessen localized vasculopathy, and speed up the recovery from muscular exhaustion and muscle function by boosting metabolic secretion and waste disposal.

The review includes five studies, explored the IASTM's effect on disability. Out of which, four studies have shown significant improvement in disability (32,25,20,27) whereas, one study showed no statistically significant improvement in disability but the improvements were clinically significant (30). The improvement in disability can be attributed to improvement in the variables such as pain, function, range of motion and other outcome variables in the studies that have improved the disability in the included studies.

Out of 18 studies in the current review, 16 studies favored IASTM as an efficient treatment for impairments, either by itself or in combination with other treatments. Only 2 trials (18,23) did not support IASTM as an effective intervention since they did not yield meaningful outcomes. IASTM offers advantages in physical therapy by enhancing tissue mobility and flexibility, benefiting athletes and injury recovery. It targets soft tissue restrictions effectively, improving athletic performance and movement efficiency. Sessions are quick and minimally invasive, but disadvantages include potential side effects like bruising and discomfort, requiring proper training and certification. Limited scientific evidence compared to alternative treatments and potential contraindications necessitate careful assessment. Additionally, the cost of sessions may be a concern (40-42). However, the majority of studies supported IASTM, indicating it as a helpful tool that can be coupled with other interventions or used alone to treat a variety of athletic and musculoskeletal conditions. Hence, it can be interpreted that IASTM is an effective tool in management of athletic and musculoskeletal conditions.

Limitations

The scarcity and diversity of evidence around IASTM is the primary constraint of this systematic review. Comparing the outcomes of trials using IASTM therapy alone vs those using IASTM implement as adjunct of a treatment plan with other adjunct therapies. It is challenging to differentiate the results when the IASTM treatment is used with patient who may retort to IASTM therapy alone but who are more likely to benefit from adjunct therapy specially when given the flexible methodology (e.g., varying treatment times, applying static versus dynamic IASTM treatment, etc.), employed throughout research, it is therefore difficult to evaluate the effectiveness of IASTM treatment, especially when used in combination. It is difficult to apply the findings to clinical practice because of the variety of the present IASTM research. Finding the best treatment protocol is challenging because study procedures vary so much, including the study population, IASTM intervention type, dosing regimen, and outcome measurements. No hand-searching was conducted. Only databases such as PubMed, PEDro, and the Cochrane Library were used for the search strategy

Clinical Recommendations for Future Research

To further understand the hypothesized physiological principles underlying the various athletic and musculoskeletal conditions, clinicians may also find it helpful to read related research on athletic and musculoskeletal conditions.

Conclusion: The analysis and synthesis of existing evidence concluded that IASTM is a valuable tool for managing athletic and musculoskeletal conditions. Its adaptability allows integration into multidisciplinary treatments, enhancing patient outcomes and quality of life in rehabilitation.

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MATERIALS	Taking responsibility for the materials	
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