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"IDUHES" dergisi elektronik ortamda ve uluslararası standartlarda yayın yapan, Türkçe ve İngilizce çalışmalara yer veren hakemli bir dergi olmak üzere Mayıs, Eylül ve Aralık aylarında yılda üç kez yayınlanmaktadır. Dergide yayınlanan yazıların içerikleriyle ilgili olarak tüm sorumluluk yazara/yazarlara aittir.

İzmir Demokrasi Üniversitesi olarak sağlık bilimleri alanında yayın yapan IDUHES adlı dergimizle 2018 Mayıs ayında yayın hayatına başlamıştık. Yedinci yılımızın üçüncü sayısını (Aralık 2024) sizlerle paylaşmanın mutluluğunu yaşıyoruz. İnternet ortamında açık erişim olanağı veren, IDUHES dergisi elektronik ortamda, ulusal ve uluslararası standartlarda yayın yapan, Türkçe ve İngilizce çalışmalara yer veren, hakemli bir dergi olup, yılda Mayıs, Eylül, Aralık ayları olmak üzere üç kez yayınlanmaktadır.

20 Ağustos 2016 tarihinde kurulan İzmir Demokrasi Üniversitesi, 2017- 2018 eğitim-öğretim döneminde lisans ve yüksek lisans eğitimine başlamıştır. İzmir Demokrasi Üniversitesi olarak geçen çok kısa zaman diliminde akademik olarak hızlı bir büyüme sağlanmıştır. Bu akademik büyümeyi planlı ve sağlam bilimsel temellere oturtmayı kendisine görev edinmiştir.

Yedi yıl önce yayın hayatına başlayan IDUHES dergimiz Sağlık Bilimleri Enstitümüzdeki programlar ve gelecekteki büyüme hedeflerimizi göz önüne alarak geniş bir bilimsel yelpazeyi kapsamaktadır. Dergimizde tıp, diş hekimliği, veteriner hekimlik, eczacılık, beslenme ve diyetetik, fizyoterapi ve rehabilitasyon, spor bilimleri, hemşirelik, ebelik, sağlık kurumları yöneticiliği, iş sağlığı ve güvenliği, dil ve konuşma terapisi ile ilişkili (disiplinlerarası dahil) çalışmalar kabul edilmektedir.

Bir derginin talep görmesi ve akademik çevrelerde kabul görmesinin temelinde içeriğini oluşturan makaleler yer almaktadır. Kısaca bir dergiyi özellikli yapan içindeki makalelerdir. Hedefimiz IDUHES'in gelecekte daha da özellikli bir dergi konumuna gelmesidir.

IDUHES Dergisi olarak bu yılın üçüncü sayısı ile farklı sağlık alanlarında bilimsel çalışmalara yer vererek paylaşım yapmanın mutluluğu ve hep birlikte sağlıklı günlere doğru yürümenin inancı içerisindeyiz.

Dergimizin yayınlanmasında yayın kurulları, danışma kurulu üyeleri ve hakemlerinin bu süreçteki katkıları büyüktür. Tüm emeği geçenlere ve değerli çalışmalarını dergimize gönderen yazarlarımıza ve okuyucularımıza katkılarından ötürü teşekkür eder, sağlık, mutluluk ve başarı dolu günlerde görüşmeyi dilerim.

Prof. Dr. Bedriye TUNÇSİPER

İzmir Demokrasi Üniversitesi Rektörü

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Merhabalar Sayın Okuyucular;

IDUHES'in yedinci yılının üçüncü sayısında farklı sağlık konularının bulunduğu değerli makalelerimiz ile bir aradayız;

Bu sayımızda Sağlık Bilimleri ve Tıp alanlarından Türkçe veya İngilizce olarak yer alan birbirinden değerli makalelerimizin başlıkları ***"Lomber Diskektomi Cerrahisi Sonrasi Yürümedeki Değişikliklerin İncelenmesi, The Molecular Mechanism, Types And Treatment Of Scar Formation, Determination Of Internet Use Among Pregnant Women And Affecting Factors: An Analytical And Cross-Sectional Study, The Relationship Of Unimanual And Bimanual Capacity With Perceived Bimanual Performance In Children With Unilateral Cerebral Palsy, Teleradyoloji Alanındaki Bilimsel Yayınların Bibliyometrik Ve İçerik Analizi İle İncelenmesi"*** *şeklindedir.*

Yayın hayatımızın yedinci yılının üçüncü sayısında sizlerle birlikte daha da güçlendiğimizi hissediyoruz. İzmir Demokrasi Üniversitesi Ailesi olarak bu sayının hazırlanmasında tüm emeği geçenlere, yazarlarımıza ve okuyucularımıza gösterdiğiniz yoğun ilgiden ötürü teşekkür eder, yeni yılın herkese sağlık, başarı ve mutluluk getirmesini dilerim.

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Olgu Sunumu – Case Report

LOMBER DİSKEKTOMİ CERRAHİSİ SONRASI YÜRÜMEDEKİ DEĞİŞİKLİKLERİN İNCELENMESİ

INVESTIGATION OF CHANGES IN GAIT AFTER LUMBAR DISCECTOMY SURGERY

Fatma ÖZ[1], Şeref Duhan ALTUĞ[2]

Özet

Lomber disk herniasyonlarının tedavisinde diskektomi cerrahisi en sık kullanılan cerrahi yöntemlerdendir. Çalışmanın amacı lomber diskektomi cerrahisi geçirmiş bir hastanın cerrahi sonrası 3. ayda yürüyüşünde meydana gelen değişiklikleri incelemektir. Bu çalışmada tek seviye diskektomi cerrahisi uygulanan 54 yaşında bir kadın hasta değerlendirildi. Değerlendirmeler cerrahiden 3 ay sonra yapıldı. Hastanın demografik ve klinik bilgileri kaydedildikten sonra, ağrı şiddeti Vizüel Analog Skalası ile (VAS), özür durumu Oswestry Özürlülük İndeksi ile ve yürüme parametrelerinde meydana gelen değişiklikler G-Walk Yürüme Analiz Sistemi ile değerlendirildi. Hastanın cerrahi sonrasında yürüme parametrelerinde meydana gelen değişiklikler incelendiğinde; yürüme kalitesinin simetrik olmadığı, kadansın ve yürüme hızının düştüğü belirlendi. Ayrıca duruş fazının sağ ve sol ekstremitede arttığı, sallanma fazının ise sağ ve sol tarafta azaldığı bulundu. Çift destek periyodunun arttığı, etkilenen ekstremitede tek destek fazının azaldığı ve adım uzunluğunun arttığı tespit edildi. Lomber cerrahiler sonrasında cerrahi geçiren hastalarda yürüme parametrelerinde önemli düzeyde değişiklikler meydana gelmektedir. Cerrahi geçiren hastalarda postoperatif dönemde normal ve simetrik bir yürüyüş paterninin kazandırılması için rehabilitasyon programında yürüme eğitimi verilmelidir.

Anahtar Kelimeler: Lomber Diskektomi, Yürüyüş Analizi, Oswestry Disabilite İndeksi

Abstract

Discectomy surgery is one of the most commonly used surgical methods in the treatment of lumbar disc herniations. The aim of the study was to examine the changes in the gait of a patient who underwent lumbar discectomy surgery in the third month after surgery. In this study, a 54-year-old female patient who underwent single-level discectomy surgery was evaluated. The evaluations were made 3 months after surgery. After recording the patient's demographic and clinical information, pain intensity was evaluated with the Visual Analogue Scale (VAS), disability status with the Oswestry Disability Index, and changes in gait parameters were evaluated with the G-Walk Gait Analysis System. When the changes in the patient's walking parameters after surgery were examined; it was determined that walking quality was not symmetrical and cadence and walking speed decreased. It was also found that the stance phase increased on the right and left extremities, and the swing phase decreased on the right and left limbs. It was determined that the double support period increased, the single support phase decreased in the affected extremity, and the step length increased.

After lumbar surgery, significant changes occur in gait parameters in patients who undergo surgery. In patients who have undergone surgery, walking training should be given in the rehabilitation program to gain a normal and symmetrical gait pattern in the postoperative period.

Keywords: Lumbar Discectomy, Gait Analysis, Oswestry Disability Index

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1. GİRİŞ

Lomber disk herniasyonunda (LDH) fıtıklaşmış disk ve nukleus pulposusun efüzyonuna yol açan annulus fibrozusun yırtılması ile karakterizedir (Atsidakou ve ark., 2021, ss. 99-105). Hastalığın klinik semptomları arasında alt ekstremitelerde güçsüzlük, bele ve bacağa yayılan şiddetli ağrı, parestezi ve hipostezi vardır (Atsidakou ve ark., 2021, ss. 99-105; Qvarfordh ve ark., 2014, ss. 377-384; Taşkaya ve ark., 2022, ss. 24-33). 30-50 yaş arasında çalışan bireyleri daha çok etkilemekte ve yaşam boyunca prevalansı %80'leri, yıllık hastane başvuru oranları ise %15'i bulmaktadır (Ghent ve ark., 2020, ss. 111-116; Sarı ve Aydoğan, 2015, ss. 298-304).

LDH olan hastaların tedavisinde cerrahi ve konservatif yöntemler kullanılmaktadır (Taşkaya ve ark., 2022, ss. 24-33). Diskektomi cerrahisi, lomber disk hernisi için en sık uygulanan cerrahi prosedürlerdendir (Rasouli ve ark., 2014). LDH tedavisi için yapılan cerrahi prosedürler ve kullanılan cerrahi teknikler son 20 yılda ciddi oranda bir artış göstermiştir. Fakat bu ilerlemeye rağmen, müdahale sonrası hasta sonuçlarında bir iyileşme söz konusu olup olmadığı henüz kesin değildir. Hastaların yaklaşık %40'ında cerrahi sonrasında semptomlarındaki iyileşmenin çok az olduğunu ya da hiç olmadığını bildirmektedirler (Gilmore ve ark., 2019).

Yürüme, tüm yaş grupları için uygun olan, hastaların kaybettiği fonksiyonlarını tekrar kazanmalarına ve ameliyattan sonra devam eden semptomlarını iyileştirmeye yönelik yardımcı olacak en güvenli, en kolay ve en uygun maliyetli bir aktivitedir (Aldemir ve Gürkan, 2021). Cerrahiden sonra hastaların çoğu bir fizyoterapist tarafından erken rehabilitasyon programına alınır ve rehabilitasyon programında bağımsız hareketliliğin sağlanıp düzenli yürümenin teşvik edilmesi üzerine odaklanılır (Gilmore ve ark., 2018, ss. 3793-3799). Ameliyattan sonraki dönemde iyileşmenin ilerlemesi için özel olarak tasarlanan rehabilitasyon programları cerrahinin başarısını artırabilir. Fakat cerrahiden sonra rehabilitasyon etkinliğini araştıran çalışma sayısı çok azdır (Gilmore ve ark., 2019).

Teknolojik ilerlemeler, giyilebilir ivmeölçerler biçiminde yürüyüş analizi yapabilen cihazların ortaya çıkmasına yol açmıştır. İvmeölçer kullanılarak yapılan nesnel ölçümler, lomber cerrahi sonrası yürüme değerlendirilmesinde gittikçe yaygınlaşan bir yöntemdir (Atsidakou ve ark., 2021, ss. 99-105; Gilmore ve ark., 2019). Bu yöntem yardımıyla hastaların yürüyüş hızı, süresi, sallanma fazı, tek destek fazı, çift destek fazı gibi yürüme parametrelerinde meydana gelen değişimler incelenebilmektedir.

Çalışmamız; Lomber diskektomi cerrahisi geçirmiş bir hastanın cerrahi sonrası 3. ayda yürüyüş fonksiyonlarının normal değerlere dönüp dönmediğini araştırmak amacıyla yapıldı.

2. YÖNTEM

Çalışmamız Pamukkale Üniversite Hastanesi Beyin ve Sinir Cerrahisi Anabilim Dalı, Fizyoterapi ünitesinde yapıldı. Bu çalışma ön çalışma niteliğinde olup bir vaka incelemesidir. Araştırmaya dahil edilme gönüllülük esasına dayandırıldı ve araştırmamızda katılmaya gönüllü olan olguya bilgilendirilmiş gönüllü onam formu imzalatıldı. Çalışmamız Helsinki Deklerasyonu Prensiplerine uygun olarak yapıldı. Olgumuz 54 yaşında ve lumbal disk herniasyonu sonucu tek seviye diskektomi cerrahisi geçiren kadın hasta post-operatif 3. ayda değerlendirildi.

Katılımcının demografik ve klinik bilgileri veri formuna kaydedildi. Çalışmaya katılan olgunun ağrı değerlendirilmesi Vizüel Analog Skalası (VAS), özür durumu Oswestry Özürlülük İndeksi ile ve yürüme parametrelerinde meydana gelen değişiklikler G-Walk Yürüme Analiz Sistemi ile değerlendirildi.

Çalışmaya dahil edilme kriterleri;

- 20-65 yaş arasında olup hastaneden taburcu edilen,
- Çalışmaya katılmayı kabul eden,
- Cerrahiden sonra 3 ay geçmiş,
- Başka bir ortopedik ve nörolojik problemi olmayan,
- İletişim problemi olmayan.

Çalışmadan hariç tutulma kriterleri;

- Kognitif bozukluğu olan,
- Disk herniasyonu dışında eşlik eden başka nörolojik, psikiyatrik ve/veya ortopedik problemi olan,
- Tıbbi olarak stabil olmayan,
- Yürüme cihazının bağlanacağı alanda açık yara, dolaşım problemi, deri lezyonu olan birey çalışma dışı bırakıldı.

Değerlendirme yöntemleri cerrahiden 3 ay sonra yapıldı.

2.1. Demografik ve klinik veri formu

Demografik ve klinik veri formu; tanı, yaş, cinsiyet, boy, kilo, vücut kitle indeksi (VKİ), doğum tarihi, sigara kullanımı gibi bilgileri içeren formdur.

2.2. Vizüel analog skala (VAS)

Vizüel Analog Skala (VAS); 10 cm'lik dikey bir çizgiden oluşmaktadır. Hastadan ameliyattan sonraki ağrı düzeyini 0 hiç ağrı yok, 10 dayanılmaz ağrı var olmak üzere 10 cm'lik çizgi üzerinde işaretlemesi istenir. Hesaplama yapılırken işaretlenen nokta ile başlangıç noktası arasındaki mesafe cm cinsinden ölçülür. Skorun artması ağrının şiddetinin arttığı anlamına gelmektedir (Atılgan ve Erbahçeci, 2018, ss. 3793-3799).

2.3. Oswestry özürlülük indeksi

Oswestry Özürlülük İndeksi; Türkçe geçerlik ve güvenirliği 2004 yılında gösterilen, bel ağrısında fonksiyon kaybının derecesini değerlendirmek için geliştirilmiş Oswestry

Özürlülük İndeksi (OÖİ), 10 maddeden oluşmaktadır. Maddeler ağrı şiddetini, kendine bakımı, yük kaldırma-taşıma, yürüyüş, oturma, ayakta durma, uyku, ağrının değişme derecesini, yolculuk ve sosyal hayatı sorgulamaktadır. Her maddenin altında hastanın durumuna uygun olanı işaretlediği altı seçenek vardır. İlk seçenek "0", altıncı seçenek "5" olarak puanlanır. Toplam puan hesaplanır ve yüzdeye çevrilerek söylenir. Maksimum puan "50", minimum puan "0"dır. Toplam skor arttıkça özürlülük düzeyi de artmaktadır (Yakut ve ark., 2004, ss. 581-585).

2.4. BTS G-Walk yürüme analiz sistemi

BTS G-Walk Yürüme Analiz Sistemi; BTS G-Walk yürüme analiz sisteminde, hastanın L5-S1 seviyesine bir kemerle yardımıyla takılan analiz portu yürümeyi analiz eder ve sonuçlar bluetooth ile bilgisayara aktarılır. BTS G-Walk ile yürümenin sağ ve sol taraftaki kalitesi, duruş fazı (topuk vuruşu ile başlayıp aynı ayağın parmaklarının temas yüzeyinden ayrılması ile sonlanan faz), sallanma fazı (ayak parmaklarının destek yüzeyinden ayrılmasıyla başlayan ve topuğun yere değmesi ile sonlanan faz), tek destek fazı (tek ekstremitenin yere temas ettiği faz), çift destek fazı (yürüyüş esnasında her iki ekstremitenin yere temas etmesiyle oluşan faz), kadans (dakikadaki adım sayısı), yürüme süresi, adım uzunluğu (bir topuğun yere temas eden noktası ile diğer topuğun yere temas eden noktası arasındaki mesafe), yürüme hızı (belirli bir zaman aralığı içerisinde alınan mesafe) gibi yürüyüşün genel kinematik bilgilerine ulaşılabilir. Cihaz içinde olması gereken normal değerlerin gösterilmesi ile de çıkan değerler arası karşılaştırma yapılabilmektedir (Wren ve ark., 2011, ss. 149-153).

3. BULGULAR

Çalışmamıza katılan olgunun demografik verileri Tablo 1'de gösterilmiştir.

Tablo 1: Hastanın Demografik Özellikleri

Değişkenler	
Yaş(yıl)	54
Cinsiyet	Kadın
Vücut ağırlığı(kg)	61
Boy uzunluğu(cm)	158
VKİ (kg/m^2)	24,4

kg: kilogram; cm: santimetre; VKİ: Vücut Kitle İndeksi; kg/m^2: kilogram/metrekare

Çalışmaya katılan olgunun Vizüel Analog Skalası incelendiğinde; ağrı puanı 1,7 idi. Çalışmaya katılan olgunun Oswestry Özürlülük İndeksi incelendiğinde; olgunun ölçek puanı 10 ve elde edilen puanın yüzdesel ifadesi %20 idi. Bu verilere göre hastanın bel ağrısı hastanın günlük yaşamını hafif derecede kısıtlamaktadır (Tablo 2).

Tablo 2: Oswestry Özürlülük İndeksi Puanı

	Ölçek Puanı	Hastanın Puanı
Engellilik Yok	(0-4) (%0-20)	-
Hafif	(5-14) (%20-40)	10 (%20)
Orta	(15-24) (%40-60)	-
Ciddi	(25-34) (%60-80)	-
Tam/İleri Derecede	(35-50) (%80-100)	-

%: yüzde

Çalışmaya katılan olgunun yürüyüş analizindeki spatio-temporal parametreleri incelendiğinde; 10 metrelik mesafeyi yürüyüş süresi 18,1 saniye idi. Kadansı 110,50±2,79 adım/dakika idi. Yürüyüş hızı 1,01±0,00 metre/saniye idi. Adım uzunluğu sağ 49,86±1,41 ve sol 50,14±0,88 idi. Çift adım uzunluğu sağ ve solda 1,10±0,02 metre idi (Tablo 3). Yürümenin spatio-temporal parametrelerinin normatif değerleri Tablo 3'te gösterildi.

Tablo 3: Yürümenin Spatio-Temporal Parametreleri

Değişkenler	Hastanın Değerleri	Normatif Değerler
Yürüyüş süresi (s)	18,1	13,1-14.3
Kadans (adım/dakika)	110,50±2,79	121,80±7,80
Hız (m/s)	1,01±0.00	1,11±0,10
Adım uzunluğu (Sağ)	49,86±1,41	50,00±0,07
Adım uzunluğu (Sol)	50,14±0.88	50,00±0,07
Çift adım uzunluğu (Sağ)	1,10±0.02	1,07±0,05
Çift adım uzunluğu (Sol)	1,10±0.02	1,07±0,05

s: saniye; m/s: metre/saniye

Çalışmaya katılan olgunun yürüme fazı parametreleri incelendiğinde; sağ yürüme kalitesi %97,4 idi. Sol yürüme kalitesi %99 idi. Duruş fazı sağ %61,29±1,14, sol %60,49±1,45 idi. Sallanma fazı sağ %38,71±1.14, sol %39,51±1,45 idi. Tek destek fazı sağ %39,38±1,37 ve sol %38,47±1,52 idi. Çift destek fazı sağ %21,91±2,38, sol %22,02±2,95 idi (Tablo 4). Yürüme fazı parametrelerinin normatif değerleri Tablo 4'te verildi.

Tablo 4: Yürüme fazı parametreleri

Değişkenler	Hastanın Yürüme Değerleri (%)	Normatif Yürüme Değerleri (%)
Sağ yürüme kalitesi	97,4	100
Sol yürüme kalitesi	99	100
Duruş fazı (Sağ)	61,29±1,14	58,98±1,97
Duruş fazı (Sol)	60,49±1,45	58,98±1,97
Sallanma fazı (Sağ)	38,71±1,14	40,03±3,56
Sallanma fazı (Sol)	39,51±1,45	40,03±3,56
Tek destek fazı (Sağ)	39,38±1,37	38,87±2,57
Tek destek fazı (Sol)	38,47±1,52	38,87±2,57
Çift destek fazı (Sağ)	21,91±2,38	20,54±6,18
Çift destek fazı (Sol)	22,02±2,95	20,54±6,18

%: yüzde

4. TARTIŞMA

Tek seviye diskektomi cerrahisi geçiren olguda post-operatif 3. ayda yapmış olduğumuz yürüyüş değerlendirmesi sonucunda; 10 m yürüyüş süresinin normatif değerler (yaşa göre) ile karşılaştırıldığında arttığını belirledik. Yürümenin spatio-temporal parametrelerinden yürümenin hızı ve kadansının azaldığı, çift adım uzunluğunun arttığı ve etkilenen taraf (sol) adım uzunluğunun arttığı, etkilenmeyen tarafta adım uzunluğunun azaldığı görüldü.

Yürüme fazı parametrelerinde yürüme kalitesinin azaldığı, duruş fazının sağ ve sol ekstremitede arttığı, sallanma fazının azaldığı ve çift destek periyodunun arttığı tespit edildi.

Ghent ve arkadaşları yapmış olduğu çalışmada tek seviye disk operasyonu geçiren hastalarda cerrahiden ortalama 66 gün sonra giyilebilir cihaz ile yürüme parametrelerini değerlendirdiklerinde günlük adım sayısının arttığını, yürüme hızının 1,19m/s olduğu, adım uzunluğunun arttığını ve OÖİ değerinin 54,54'ten 16,33'e düşerek özürlülük oranının azaldığını tespit etmiştir (Ghent ve diğerleri, 2020).

Kim ve arkadaşları bel cerrahisi geçiren 22 hasta üzerinde yaptıkları çalışmada pre-operatif ve post-operatif yürüme, VAS ve OÖİ değerlerini incelemiştir. Bir ay sonraki ölçümlerde VAS değerinin 7,4'ten 1,4'e düştüğü ve Oswestry özürlülük indeksi değerinin 58.6'dan 22.5'e düşerek özürlülük oranının azaldığını tespit etmişlerdir. Ayrıca yapılan çalışmada hastaların ne kadar çok ağrısı azalırsa yürüme mesafesinin de o kadar çok arttığı görülmüştür (Kim ve diğerleri, 2018).

Mobbs ve arkadaşlarının 11'i tek seviye olan ve 2'si iki seviye olan lumbal cerrahi geçiren 13 hasta üzerinde ivmeölçer yardımıyla yürüme analizini değerlendirdikleri ve ortalama takip süresi 92 gün olan çalışmada yürüyüş hızının 0,8 m/s'den 1,11m/s'ye, çift adım uzunluğunun 1 m'den 1,26 m'ye çıktığını ve Oswestry özürlülük indeksi skorunun 50,46'dan 31,85'e anlamlı olarak değiştiğini ve özürlülük oranının azaldığını gözlemlemişlerdir. Ameliyat öncesine göre adım sayısında, yürüme hızında, adım uzunluğunda ve postüral skorda anlamlı artış görülmüştür (Mobbs ve diğerleri, 2019).

Mobbs ve arkadaşları bel ağrısı sebebi ile lomber omurga ameliyatı geçiren 28 hastayı ameliyat öncesi ve ameliyat sonrası 3 aylık dönemde ivmeölçer aracılığıyla incelemişlerdir. Ameliyat öncesi dönemde günlük ortalama yürüme mesafesi 3,8 km iken, 1 aylık takipte bu sayı 3,4 km, 2 aylık takipte 5,3 km'ye ve 3 aylık takipte 6,2 km'ye yükseldiğini saptamışlardır. VAS ağrı skorunda 7,0'dan 2,8'e azalma olduğunu ve Oswestry özürlülük indeksi skorunda 46,0'dan 26,9'a anlamlı bir azalış olduğu ve özürlülük oranının düştüğünü tespit etmişlerdir (Mobbs ve diğerleri, 2016).

Bonab ve arkadaşları lomber mikrodiskektomi cerrahisi geçiren 59 LDH hastasını pre-operatif dönemde ve post-operatif 15. günde yürüyüş parametreleri açısından incelemişlerdir. Win-Track yürüyüş analiz platform sistemi kullanılarak yapılan çalışmada hızın 0,69 m/s'den 0,94 m/sn'ye, kadansın 91,07 adım/dakikadan 106,70 adım/dakikaya çıktığını görmüşlerdir. Adım süresi, çift destek fazı süresi ve salınım fazı süresinde anlamlı oranda azalma, adım uzunluğunda ise anlamlı oranda artma tespit etmişlerdir (Bonab ve diğerleri, 2023).

Bizim çalışmamızda da sonuçlarımızın literatüre paralel olduğu, post-operatif 3. ayda 10 metre yürüyüş süresinin arttığı, yürümenin Spatio-temporal parametreleri incelendiğinde hızı ve kadansının azaldığı, çift adım uzunluğunun arttığı ve etkilenen tarafta (sol) adım uzunluğunun arttığı, etkilenmeyen tarafta adım uzunluğunun azaldığı belirlendi. Yürüme fazı parametrelerinde yürüme kalitesinin azaldığı, duruş fazının sağ ve sol ekstremitede arttığı, sallanma fazının azaldığı ve çift destek periyodunun arttığı tespit edildi. Yine literatür ile aynı doğrultuda Oswestry özürlülük indeksi değerinin 10 ve VAS ağrı değerinin de 1,7 olduğu bulundu.

5. SONUÇ

Çalışmamız doğrultusunda lumbal cerrahi geçiren hastalarda post-operatif dönemde yürüme bozuklukları görülmektedir. Bu durumun ortadan kaldırılması için cerrahi sonrası erken dönemlerde zayıf olan karın, sırt ve alt ekstremite kas kuvvetlerini arttırmaya yönelik fizyoterapi programının önemi bir kez daha vurgulanmıştır.

6. KAYNAKLAR

Aldemir, K. ve Gürkan, A. (2021). The effect of pedometer-supported walking and telemonitoring after disc hernia surgery on pain and disability levels and quality of life. Internatıonal Journal of Nursıng Practıce, 27(2). https://doi: 10.1111/ijn.12917

Atılgan, E. ve Erbahçeci, F. (2018). Kronik bel ağrılı bireylerde yoga ve fizyoterapi programının yaşam kalitesi, denge, ağrı düzeyi ve uyku kalitesi üzerine etkilerinin karşılaştırılması. Journal of Exercise Therapy and Rehabilitation, 5(3), 158-166.

Atsidakou, N., Matsi, A. E., Christakou A. (2021). The effectiveness of exercise program after lumbar discectomy surgery. Journal of Clinical Orthopaedics and Trauma, 16, 99-105. https://doi: 10.1016/j.jcot.2020.12.030

Bonab, M. A. R., Şener, S., Çolak, T., Amirrashedi, M., Yeldan, İ., Konya, D., Toktaş, Z. O. (2023). Spatiotemporal gait parameters and gait asymmetry in patient with lumbar disc herniation, treated with microdiscectomy: A prospective, observational study. Neurospine, 20(3), 947-958. https://doi: 10.14245/ns.2346122.061

Ghent, F., Mobbs, R. J., Mobbs, R. R., Sy, L., Betteridge, C., Choy, W. J. (2020). Assessment and post-intervention recovery after surgery for lumbar disk herniation based on objective gait metrics from wearable devices using the gait posture index. World Neurosurgery, 142, 111-116. https://doi: 10.1016/j.wneu.2020.06.104

Gilmore, S. J., Hahne, A. J., Davidson, M., McClelland, J. A. (2019). Predictors of substantial improvement in physical function six months after lumbar surgery: Is early post-operative walking ımportant? A prospective cohort study. BMC Musculoskeletal Disorders, 20:418 https://doi: 10.1186/s12891-019-2806-7

Gilmore, S. J., Hahne, A. J., Davidson, M., McClelland, J. A., Davidson, M. (2018). Physical activity patterns of patients immediately after lumbar surgery. Disability and Rehabilitation, 42(26), 3793-3799. https://doi: 10.1080/09638288.2019.1610512

Kim, D. H., Nam, K. H., Choi, B. K., Han, I. H., Jeon, T. J., Park, S. Y. (2018). The usefulness of a wearable device in daily physical activity monitoring for the hospitalized patients undergoing lumbar surgery. Journal of Korean Neurosurgical Society, 62(5), 561-566. https://doi: 10.3340/jkns.2018.0131

Mobbs, R. J., Mobbs, R. R., Choy, W. J. (2019). Proposed objective scoring algorithm for assessment and intervention recovery following surgery for lumbar spinal stenosis based on relevant gait metrics from wearable devices: The Gait Posture Index (GPi). Journal of Spine Surgery, 5(3), 300–309. https://doi: 10.21037/jss.2019.09.06

Mobbs, R. J., Phan, K., Maharaj, M., Rao, P. J. (2016). Physical activity measured with accelerometer and self-rated disability in lumbar spine surgery: A prospective study. Global Spine Journal, 6(5), 459–464. https://doi: 10.1055/s-0035-1565259

Qvarfordh, P., Olsen, K. S., Bendix, T., Esbensen, B. A. (2014). Should patients walk from the postanesthesia care unit to the general ward after a lumbar discectomy: A randomized study. Journal of PeriAnesthesia Nursing, 29(5), 377-384. https://doi: 10.1016/j.jopan.2013.10.006

Rasouli, MR., Rahimi-Movaghar, V., Shokraneh, F., Moradi-Lakeh, M., Chou, R. (2014). Minimally invasive discectomy versus microdiscectomy/open discectomy for symptomatic lumbar disc herniation. Cochrane Database of Systematic Reviews, Issue 9. Art. No.: CD010328. https://doi: 10.1002/14651858.CD010328.pub2

Sarı, S., Aydoğan, M. (2015). Bel ağrısının önemli bir sebebi lomber disk hernisi. TOTBİD Dergisi, 14, 298-304. https://doi: 10.14292/totbid.dergisi.2015.47

Taşkaya, B., Taşkent İ., Çakıllı M., Yılmaz, Ö. (2022). Lumbal disk herniasyonu hastalarında ağrı ve fonksiyonel durum arasındaki ilişki. MAUN Sağlık Bilimleri Dergisi, 2(2), 24-33.

Wren, T. A., Gorton, G. E., Ounpuu, S., Tucker, C. A. (2011). Efficacy of clinical gait analysis: A systematic review. Gait and Posture. 34 (2), 149-153. https://doi: 10.1016/j.gaitpost.2011.03.027

Yakut, E., Düger, T., Oksüz, Ç., Yörükan, S., Ureten, K., Turan, D., Fırat, T., Kiraz, S., Krd, N., Kayhan, H., Yakut, Y., Güler, Ç. (2004). Validation of the Turkish version of the Oswestry Disability Index for patients with low back pain. Spine, 29(5), 581-585. https://doi: 10.1097/01.brs.0000113869.13209.03.

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Review Paper - Derleme Makalesi

THE MOLECULAR MECHANISM, TYPES AND TREATMENT OF SCAR FORMATION

SKAR OLUŞUMUNUN MOLEKÜLER MEKANİZMASİ, TÜRLERİ VE TEDAVİSİ

Enver TEKİN[1]

Özet

Yara iyileşmesi ve skar oluşumu, hasara yanıt olarak hücre dışı matris bileşenlerinin birikmesi ve fibroblastların çoğalmasıyla karakterize karmaşık bir biyolojik süreçtir. Yara iyileşmesinin ve sonrasında oluşan skar oluşumunun altında yatan mekanizmaları, hipertrofik skar ve keloid gibi skar tiplerine bağlı olarak önemli ölçüde değişebilmekte ve çeşitli hücresel ve moleküler faktörlerden etkilenmektedir. Fibroblastların farklılaşmış bir formu olan miyofibroblastlar, kasılma özellikleri ve büyük miktarda kolajen ve diğer hücre dışı matris bileşenleri üretme kabiliyetleri nedeniyle yara iyileşmesinde ve skar oluşumunda önemli bir rol oynarlar. Skar oluşum süreci fibroblastlar, makrofajlar ve endotel hücreleri gibi çeşitli hücre tipleri ile hücre dışı matris bileşenleri arasındaki karmaşık etkileşimleri içerir. Bu mekanizmaların anlaşılması, hipertrofik skar ve keloid gibi patolojik skarları en aza indirmeye yönelik tedavi stratejileri geliştirmek için çok önemlidir. Skar oluşumunun ilk evresinde, iyileşme sürecinin ilk aşaması olan inflamasyon mekanizması başlar. Özellikle makrofajlar olmak üzere inflamatuar hücreler, yara iyileşmesinin düzenlenmesinde önemli bir rol oynarlar. Fibroblastlar, kollajen de dahil olmak üzere ekstraselüler matriks bileşenlerinin sentezlenmesinden sorumlu olan, skar oluşumunda birincil etkili hücrelerdir. Skarlar, özelliklerine, altta yatan mekanizmalarına ve klinik görünümlerine göre çeşitli türlere ayrılabilir. En sık tartışılan iki tür hipertrofik skar ve keloiddir, ancak atrofik skar, kontraktür skar ve akne skarı da görülebilir ve her biri tedavi için farklı özelliklere sahiptir. Bu çalışmanın amacı skar oluşumunun moleküler mekanizmasını, tiplerini ve tedavisini açıklamaktır.

Anahtar Kelimeler: Yara İyileşmesi, Skar, Fibroblast, İnflamasyon, Keloid, Hipertrofik Skar

Abstract

Wound healing and scar formation is a complex biological process that occurs as a response to injury, characterized by the deposition of extracellular matrix components and the proliferation of fibroblasts. The mechanisms underlying wound healing and following scar formation can vary significantly depending on the type of scar, such as hypertrophic scars and keloids, and are influenced by various cellular and molecular factors. Myofibroblasts, a differentiated form of fibroblasts, play a pivotal role in wound healing and scar formation due to their contractile properties and ability to produce large amounts of collagen and other extracellular matrix components. Scar formation process involves complex interactions among various cell types, including fibroblasts, macrophages, and endothelial cells, as well as the extracellular matrix components. Understanding these mechanisms is crucial for developing therapeutic strategies to minimize pathological scarring, such as hypertrophic scars and keloids. The initial phase of scar formation is dominated by inflammation, which is essential for initiating the healing process. Inflammatory cells, particularly macrophages, play a pivotal role in orchestrating the wound healing response. Fibroblasts are the primary effector cells in scar formation, responsible for synthesizing extracellular matrix components, including collagen. Scars can be classified into several types based on their characteristics, underlying mechanisms, and clinical presentations. The two most commonly discussed types of scars are hypertrophic scars and keloids, but there are also atrophic scars, contracture scars, and acne scars, each with distinct features and implications for treatment. The aim of this study is to explain the molecular mechanism, types and treatment of scar formation.

Keywords: Wound Healing, Scar, Fibroblast, Inflammation, Keloid, Hypertrophic Scar

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1. INTRODUCTION

Wound healing is a multifaceted biological process that involves a series of complex interactions among various cell types, growth factors, cytokines, and the extracellular matrix (ECM). The process can be broadly categorized into four overlapping phases:

-hemostasis,
-inflammation,
-proliferation,
-remodeling.

Each phase is crucial for the successful repair of damaged tissue, and disruptions at any stage can lead to chronic wounds or impaired healing, particularly in populations with underlying conditions such as diabetes mellitus (Walther et al., 2022, pp.241-254; Moura et al., 2019, pp.1-11; Wei et al., 2022, pp. 1-27).

The initial phase of wound healing, **hemostasis**, involves the constriction of blood vessels and the aggregation of platelets to form a clot, which serves as a temporary matrix for incoming cells. This is followed by the **inflammatory phase**, characterized by the recruitment of immune cells to the wound site, which helps to clear debris and pathogens. Key growth factors such as Platelet-Derived Growth Factor (PDGF) and Transforming Growth Factor-beta (TGF-β) play significant roles in this phase by promoting chemotaxis and proliferation of fibroblasts and endothelial cells (Zhang et al., 2014, pp. 1-8; Noh et al., 2018, pp. 240-247). The presence of these growth factors is essential for the transition from inflammation to the **proliferative phase**, where new tissue formation occurs through angiogenesis, collagen deposition, and re-epithelialization (Sun et al., 2017, pp. 1-11; Wei et al., 2022, pp. 1-27). During the proliferative phase, fibroblasts are activated and migrate to the wound site, where they synthesize collagen and other ECM components. This phase is also marked by the formation of granulation tissue, which is rich in new blood vessels and provides a scaffold for further tissue regeneration. Growth factors such as Fibroblast Growth Factor (FGF) and Vascular Endothelial Growth Factor (VEGF) are crucial for stimulating fibroblast activity and promoting angiogenesis (Wei et al., 2022, pp. 1-27; Zhang et al., 2014, pp. 1-8). Studies have shown that the application of exogenous growth factors can enhance fibroblast proliferation and migration, thereby accelerating wound healing (Walther et al., 2022, pp. 241-254; Wei et al., 2022, pp. 1-27; Noh et al., 2018, pp. 240-247). The **remodeling phase** is the final stage of wound healing, where the newly formed tissue undergoes maturation and reorganization. This phase can last for months to years, during which collagen fibers are remodeled, and the tensile strength of the wound increases. The balance between matrix metalloproteinases (MMPs) and their inhibitors is critical during this phase, as it regulates ECM degradation and remodeling (Masi et al., 2016, pp. 512-521; Qi et al., 2014, pp. 1407-1419). Disruptions in this balance can lead to hypertrophic scars or keloids, which are common complications in wound healing (Walther et al., 2022, pp.241-254; Moura et al., 2019, pp.1-11; Wei et al., 2022, pp. 1-27).

In diabetic patients, wound healing is often impaired due to a combination of factors, including reduced blood flow, neuropathy, and altered immune responses. The presence of high levels of reactive oxygen species (ROS) can also contribute to the dysfunction of growth factor signaling pathways, further complicating the healing process (Bitar and Al-Mulla, 2012, pp. 375-388). Research has indicated that diabetic wounds exhibit lower levels of key growth factors such as VEGF and FGF, which are essential for angiogenesis and fibroblast function

(Moura et al., 2019, pp. 1-11; Zhang et al., 2014, pp. 1-8; Qi et al., 2014, pp. 1407-1419). Consequently, therapeutic strategies aimed at enhancing the local concentration of these growth factors have been explored as potential interventions to improve healing outcomes in diabetic patients (Yuniati et al., 2021, pp. 1-21; Wei et al., 2022, pp. 1-27).

Recent advancements in wound care technologies have focused on the development of bioactive dressings that incorporate growth factors, antimicrobial agents, and other therapeutic compounds to enhance healing. For instance, **electrospun wound dressings** loaded with insulin and growth factors have shown promise in promoting protein expression associated with wound healing (Walther et al., 2022, pp.241-254). Similarly, **hydrogels** containing gold nanoparticles have demonstrated enhanced microbicidal properties and improved healing potential in vivo (Batool et al., 2022, pp. 1-10).

These innovative approaches aim to create a conducive environment for healing by addressing both the biological and mechanical aspects of wound repair. Moreover, the use of platelet-rich plasma (PRP) has gained attention as a regenerative therapy for chronic wounds. PRP is rich in growth factors such as PDGF, TGF-β, and VEGF, which can significantly enhance fibroblast proliferation and migration, thereby accelerating the healing process (Palumbo et al., 2021; Noh et al., 2018, pp. 240-247). Clinical studies have reported positive outcomes with PRP application in various types of wounds, including diabetic ulcers and surgical incisions (Suryanarayan et al., 2014, pp. 65-69; İnan, 2013, pp. 1-8). The combination of PRP with other modalities, such as low-level laser therapy or topical growth factor application, has also been investigated to further enhance healing efficacy (Ebrahiminaseri et al., 2021, pp. 1-23).

In addition to growth factors, the role of the ECM in wound healing cannot be overstated. The ECM provides structural support and biochemical signals that are crucial for cell migration, proliferation, and differentiation. Advances in tissue engineering have led to the development of scaffolds that mimic the natural ECM, facilitating better integration and function of the cells involved in wound healing (Dwivedi et al., 2019, pp. 1-19; Zhang et al., 2018). For example, biodegradable scaffolds that release growth factors in a controlled manner have shown promise in enhancing tissue regeneration and accelerating wound closure (Dwivedi et al., 2019, pp. 1-19; Zhang et al., 2018, pp. 1-12). Furthermore, the application of stem cell therapy in wound healing is an emerging area of research. Stem cells possess the ability to differentiate into various cell types and secrete a range of growth factors and cytokines that can modulate the healing process (Natallya et al., 2019, pp. 1-4; Prakoeswa et al., 2020, pp. 1159-1160). Studies have demonstrated that the use of stem cell-derived secretomes can promote angiogenesis and enhance the proliferation of fibroblasts and keratinocytes, thereby improving wound healing outcomes (Natallya et al., 2019, pp. 1-4; Prakoeswa et al., 2020, pp. 1159-1160). The integration of stem cell therapy with traditional wound care approaches may offer a novel strategy for managing chronic wounds.

2. MOLECULAR MECHANISM OF WOUND HEALING

Wound healing is a complex biological process that involves a series of tightly regulated molecular mechanisms. Each phase of wound healing is characterized by specific cellular activities and signaling pathways that are crucial for effective tissue repair.

Understanding the molecular mechanisms underlying wound healing is essential for developing therapeutic strategies to enhance healing, particularly in chronic wounds associated with conditions such as diabetes and aging.

The initial phase of wound healing, hemostasis, is critical for preventing blood loss and initiating the healing process. Upon injury, platelets aggregate at the site, releasing growth factors such as PDGF and TGF-β, which play pivotal roles in recruiting inflammatory cells and fibroblasts to the wound site (Donovan et al., 2013, pp. 1-9; Yang et al., 2020, pp. 1995-2002). The activation of these growth factors triggers various signaling pathways, including the mitogen-activated protein kinase (MAPK) pathway, which is essential for cell proliferation and migration during subsequent phases of healing (Guan et al., 2021, pp. 1-14). Additionally, the ECM components, such as fibronectin, provide a scaffold for cell attachment and migration, facilitating the transition from hemostasis to inflammation (Hsiao et al., 2017, pp. 70653-70668).

The inflammatory phase is characterized by the recruitment of immune cells, including neutrophils and macrophages, to the wound site. These cells release pro-inflammatory cytokines and growth factors that further promote the healing process. For instance, interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF-α) are critical for activating signaling pathways that enhance keratinocyte migration and proliferation (Vukelic et al., 2011, pp. 10265-10275; Choi et al., 2014, pp. 210-216). The resolution of inflammation is equally important, as excessive inflammation can lead to chronic wounds. The balance between pro-inflammatory and anti-inflammatory signals is mediated by various pathways, including the Janus kinase/signal transducer and activator of transcription (JAK/STAT) pathway, which has been shown to be essential for wound healing (Qin et al., 2017, pp. 465-473).

During the proliferative phase, fibroblasts play a central role in synthesizing collagen and other ECM components, which are necessary for tissue repair. The activation of fibroblasts is influenced by various growth factors, including FGF and VEGF, which promote angiogenesis and the formation of granulation tissue (Li et al., 2015, pp. 65-73). The signaling pathways involved in this phase include the phosphoinositide 3-kinase (PI3K)/Akt pathway, which is crucial for cell survival and proliferation (Wang et al., 2021, pp. 1-13). Additionally, the Notch signaling pathway has been implicated in regulating the behavior of epidermal stem cells, enhancing their ability to contribute to re-epithelialization during wound healing (Yang et al., 2016, pp. 1-7).

The remodeling phase is characterized by the maturation and reorganization of the newly formed tissue. This phase can last for months to years and involves the remodeling of collagen fibers and the restoration of tissue architecture. The balance between MMPs and their inhibitors is critical during this phase, as MMPs degrade the ECM to allow for tissue remodeling (Wang et al., 2018, pp. 1627-1638). Furthermore, the hypoxia-inducible factor (HIF) signaling pathway plays a significant role in regulating cellular responses to low oxygen levels, which are common in wounds. HIF activation promotes angiogenesis, and the expression of genes involved in ECM remodeling, thereby facilitating wound healing (Ruthenborg et al., 2014, pp. 637-643).

In diabetic wounds, the healing process is often impaired due to a combination of factors, including reduced blood flow, neuropathy, and altered immune responses. The presence of high levels of ROS can disrupt normal signaling pathways, leading to impaired fibroblast function and reduced angiogenesis (Süntar et al., 2021, pp. 2424; Li et al., 2021, pp. 509-520). Studies have shown that diabetic wounds exhibit altered expression of key growth factors, such

as VEGF and PDGF, which are essential for promoting angiogenesis and fibroblast activity (Moura et al., 2019, pp. 1-11; Zhang et al., 2014, pp. 1-8; Li et al., 2021 pp. 509-520). The activation of the Nrf2 signaling pathway has been suggested as a potential therapeutic target to enhance wound healing in diabetic patients by modulating oxidative stress and inflammation (Süntar et al., 2021, pp. 2424).

Recent advancements in wound healing therapies have focused on harnessing the molecular mechanisms involved in the healing process. For instance, the application of bioactive dressings that release growth factors in a controlled manner has shown promise in enhancing healing outcomes (Dwivedi et al., 2019, pp. 1-19; Zhang et al., 2018, pp. 1-12). Additionally, stem cell therapies have emerged as a potential strategy for promoting wound healing by providing a source of growth factors and facilitating tissue regeneration (Natallya et al., 2019, pp. 1-4; Prakoeswa et al., 2020, pp. 1159-1160). The use of PRP has also gained attention for its ability to accelerate healing through the release of various growth factors that stimulate fibroblast proliferation and migration (Palumbo et al., 2021, pp. 1-7; Suryanarayan et al., 2014, pp. 65-69). Moreover, understanding the role of microRNAs in wound healing has opened new avenues for therapeutic interventions. MicroRNAs such as miR-129 and miR-335 have been shown to promote diabetic wound healing by inhibiting the expression of MMP-9, which is associated with impaired healing (Wang et al., 2018, pp. 1627-1638). The regulation of these microRNAs may provide a novel approach to enhance the healing process in chronic wounds.

3. SCAR FORMATION

Scar formation is a complex biological process that occurs as a response to injury, characterized by the deposition of extracellular matrix (ECM) components and the proliferation of fibroblasts. The mechanisms underlying scar formation can vary significantly depending on the type of scar, such as hypertrophic scars and keloids, and are influenced by various cellular and molecular factors. This response is not merely a reparative process but can lead to pathological outcomes that affect both the physical and psychological well-being of individuals.

The initial phase of scar formation involves the activation of fibroblasts, which are crucial for synthesizing ECM proteins, including collagen. **Myofibroblasts, a differentiated form of fibroblasts,** play a pivotal role in wound healing and scar formation due to their contractile properties and ability to produce large amounts of collagen and other ECM components. Research has shown that the persistence of myofibroblasts in the wound site, due to inadequate apoptosis, is a significant contributor to excessive scarring (Darby and Desmoulière, 2020, pp. 19-26; , He et al., 2015, pp. 666-676). The TGF-β signaling pathway is particularly important in this context, as it promotes fibroblast activation and myofibroblast differentiation, leading to increased collagen deposition (Ren et al., 2014, pp. 1607-1612; , Ma et al., 2014, pp. 76-83).

Mechanical forces also significantly influence scar formation. Studies have demonstrated that mechanical stretch can activate specific ion channels, such as Piezo1, which mediates calcium signaling pathways that promote hypertrophic scar formation (He et al., 2021, pp. 1-13; Ogawa et al., 2012, pp. 149-157). The application of mechanical tension has been shown to prolong the inflammatory phase of wound healing, which correlates with increased scar formation (Wong et al., 2011, pp. 4498-4510). Furthermore, the interaction between fibroblasts and endothelial cells under mechanical strain has been suggested to drive the fibrotic

response, highlighting the importance of the biomechanical environment in scar development (Tan et al., 2023, pp. 1-15).

Hypertrophic scars are characterized by excessive collagen deposition and a thickened dermis, often resulting from an exaggerated wound healing response. The pathogenesis of hypertrophic scars involves a dysregulated inflammatory response, where pro-inflammatory cytokines and growth factors, such as TGF-β1, play crucial roles in modulating fibroblast activity and ECM synthesis (Wang et al., 2020, pp. 1-10; Pradhan, 2023, pp. 549-563). In contrast, **keloids** represent an even more severe form of scarring, where the scar tissue extends beyond the original wound margins. Genetic predisposition, along with environmental factors, contributes to the development of keloids, making them a significant clinical challenge (Ong et al., 2010, pp. 1302-1315; Williams et al., 2014, pp. 811-812).

The role of inflammation in scar formation cannot be overstated. Inflammatory cells, including macrophages and T-lymphocytes, are recruited to the wound site and secrete various cytokines that modulate fibroblast behavior and ECM remodeling (Feng et al., 2019, pp. 1-7). The intensity and duration of the inflammatory response have been correlated with the final scar size, suggesting that controlling inflammation could be a therapeutic target for minimizing scar formation (Wang et al., 2020, pp. 1-10; Zhao et al., 2023, pp. 3643-3662). Moreover, the interplay between different cell types, including endothelial cells and fibroblasts, is essential for orchestrating the healing process and determining the quality of the resulting scar (Tan et al., 2023, pp. 1-15; , Wong et al., 2011, pp. 4498-4510).

Recent advances in understanding the molecular mechanisms of scar formation have highlighted the potential for therapeutic interventions. For instance, targeting specific signaling pathways, such as the TGF-β pathway or mechanotransduction pathways, may offer strategies to mitigate excessive scarring (He et al., 2015, pp. 666-676; Pradhan, 2023, pp. 549-563). Additionally, the use of biomaterials and devices designed to modulate mechanical forces at the wound site has shown promise in reducing scar formation (Wong et al., 2013, pp. 185-194; Gurtner et al., 2011, pp. 217-225).

4. MOLECULAR MECHANISM OF SCAR FORMATION

Scar formation is a multifaceted biological process that occurs following skin injury, characterized by a series of cellular and molecular events aimed at restoring tissue integrity.

The mechanisms underlying scar formation involve complex interactions among various cell types, including fibroblasts, macrophages, and endothelial cells, as well as the ECM components. Understanding these mechanisms is crucial for developing therapeutic strategies to minimize pathological scarring, such as hypertrophic scars and keloids.

The initial phase of scar formation is dominated by inflammation, which is essential for initiating the healing process. Inflammatory cells, particularly macrophages, play a pivotal role in orchestrating the wound healing response. Macrophages can adopt different phenotypes, with M1 macrophages promoting inflammation and M2 macrophages facilitating tissue repair and remodeling (Feng et al., 2019, pp. 1-7). The balance between these macrophage populations is critical; prolonged activation of M2 macrophages can lead to excessive collagen deposition and scarring (Feng et al., 2019, pp. 1-7; Hesketh et al., 2017, pp. 1-10). Furthermore, the secretion of pro-inflammatory cytokines, such as interleukin-10 (IL-10), has been shown to modulate the

inflammatory response and influence scar formation. Increased IL-10 levels can attenuate the inflammatory response, leading to improved wound healing and reduced scarring (Morris et al., 2014, pp. 406-4146; Kieran et al., 2013, pp. 428-436).

Fibroblasts are the primary effector cells in scar formation, responsible for synthesizing ECM components, including collagen. The transition of fibroblasts to myofibroblasts is a key event in this process, driven by TGF-β signaling. TGF-β promotes the differentiation of fibroblasts into myofibroblasts, which exhibit enhanced contractile properties and increased collagen production (Volk et al., 2011, pp. 25-37; Xu et al., 2020, pp. 1-6). The dysregulation of TGF-β signaling is often implicated in pathological scarring, as excessive TGF-β activity can lead to hypertrophic scars and keloids (Takaya et al., 2022, pp. 4245; Xu et al., 2020, pp. 1-6). Moreover, the balance between collagen types I and III is crucial; while type III collagen is associated with early wound healing, excessive type I collagen deposition can result in disorganized scar tissue (Shi et al., 2013, pp. 1-10).

The ECM plays a significant role in scar formation, providing structural support and regulating cellular behavior. Decorin, a small leucine-rich proteoglycan, has been shown to inhibit fibroblast migration and promote scar formation by modulating TGF-β signaling (Takaya et al., 2022, pp. 4245). Additionally, the composition and organization of the ECM can influence the mechanical properties of the scar tissue, affecting its tensile strength and elasticity. Mechanical forces, such as tension and compression, can alter fibroblast behavior and contribute to the development of hypertrophic scars (Gurtner et al., 2011, pp. 217-225; Yannas et al., 2017, pp. 177-191). The mechanotransduction pathways that mediate these responses are critical for understanding how mechanical stimuli can lead to pathological scarring.

The remodeling phase of wound healing is characterized by the degradation of excess ECM components and the reorganization of collagen fibers. MMPs are key enzymes involved in ECM remodeling, and their activity is tightly regulated by tissue inhibitors of metalloproteinases (TIMPs) (Li et al., 2019, pp. 99-106). An imbalance between MMPs and TIMPs can lead to excessive collagen accumulation and scarring. For instance, TGF-β1 has been shown to induce MMP-1 expression, which is involved in collagen degradation, but excessive TGF-β signaling can also lead to increased collagen synthesis, resulting in hypertrophic scars (Li et al., 2019, pp. 99-106). Recent studies have highlighted the potential of targeting specific molecular pathways to mitigate scar formation. For example, the use of basic fibroblast growth factor (bFGF) has been shown to promote wound healing while reducing scar formation by inhibiting the differentiation of fibroblasts into myofibroblasts (Wang et al., 2017, pp. 1-13; , Shi et al., 2013, pp. 1-10). Additionally, the application of small molecular inhibitors targeting TGF-β signaling has shown promise in preventing hypertrophic scars by modulating fibroblast activity and ECM composition (Wang et al., 2017, pp. 1-13). Furthermore, the use of stem cell therapies and exosomes derived from stem cells has emerged as a novel approach to enhance wound healing and reduce scarring by promoting tissue regeneration and modulating inflammatory responses (Duan et al., 2020, pp. 1-11; Rong et al., 2020, pp. 1-8).

5. SCAR TYPES

Scar formation is a complex biological process that results from the body's healing response to injury. Scars can be classified into several types based on their characteristics, underlying mechanisms, and clinical presentations. The two most commonly discussed types

of scars are **hypertrophic scars and keloids**, but there are also **atrophic scars, contracture scars**, and **acne scars**, each with distinct features and implications for treatment.

Hypertrophic Scars are characterized by raised, thickened areas of skin that **remain within the boundaries of the original wound**. They often develop following surgical procedures, trauma, or burns, and are a result of an overproduction of collagen during the healing process. The **collagen fibers in hypertrophic scars are typically disorganized and densely packed**, leading to a firm texture (Tripathi et al., 2020, pp. 1-11; Gisquet et al., 2011, pp. 160-166).

The prevalence of hypertrophic scars can be notably high in certain populations, particularly among individuals with darker skin types, where the incidence can reach up to 70% following burns (Finnerty et al., 2016, pp. 1427-1436). Hypertrophic scars may improve over time, often flattening and becoming less noticeable, but they can also be associated with symptoms such as itching and discomfort (Limandjaja et al., 2020, pp. 146-161).

Keloids are a more severe form of scarring that extends beyond the original wound margins. They are characterized by an excessive accumulation of collagen and other extracellular matrix components, leading to a raised and often itchy or painful lesion. Keloids can occur after any type of skin injury, including surgical incisions, acne, or even minor injuries.

Histologically, keloids exhibit a dense collagen structure that is disorganized, with a **higher density of fibroblasts and blood vessels compared to hypertrophic scars** (Medyukhina et al., 2011, pp. 627-636; Huang et al., 2013, pp. 1-4). The pathogenesis of keloids is not fully understood, but genetic predisposition plays a significant role, and they are more common in individuals with darker skin (Limandjaja et al., 2020, pp. 146-161; Huang et al., 2013, pp. 1-4). Unlike hypertrophic scars, keloids do not typically regress over time and may require more aggressive treatment options, including corticosteroid injections, laser therapy, or surgical excision (Tripathi et al., 2020, pp. 1-11; Limandjaja et al., 2020, pp. 146-161).

Atrophic scars are another type of scar that results from a loss of tissue, leading to a depressed appearance in the skin. These scars are commonly associated with conditions such as acne, chickenpox, or other forms of skin trauma. Atrophic scars can be further classified into subtypes, including ice pick scars, boxcar scars, and rolling scars, each with distinct shapes and characteristics (Gaur, 2018, pp. 48-50; Fabbrocini et al., 2010, pp. 1-13).

The treatment for atrophic scars often involves methods aimed at stimulating collagen production and skin regeneration, such as microneedling, chemical peels, or dermal fillers (Gaur, 2018, pp. 48-50; Fabbrocini et al., 2010, pp. 1-13).

Contracture scars typically occur after burns or significant skin loss and are characterized by the tightening of the skin, which can restrict movement and function. These scars can affect the underlying muscles and tendons, leading to complications such as joint contractures. The severity of contracture scars often depends on the depth and extent of the initial injury, and they may require surgical intervention to release the tightness and restore function (Finnerty et al., 2016, pp. 1427-1436; Schouten et al., 2023, pp. 810-816).

Acne scars represent a specific subset of atrophic scars that arise from inflammatory acne lesions. They can be classified into hypertrophic and atrophic types, depending on the body's response to inflammation. The management of acne scars is particularly challenging due to their varied presentations and the need for tailored treatment approaches, which may include

laser therapy, chemical peels, or subcision (Kravvas and Al-Niaimi, 2017, pp. 1-17; Fabbrocini et al., 2010, pp. 1-13).

The classification of acne scars is crucial for guiding treatment decisions, as different types respond better to specific interventions (Gaur, 2018, pp. 48-50; Fabbrocini et al., 2010, pp. 1-13).

6. TYPES OF PATHOLOGICAL SCARS

6.1. Hypertrophic Scar Formation

Hypertrophic scar formation is a complex biological process characterized by excessive collagen deposition and fibroblast proliferation following skin injury. This condition is a common outcome of various types of wounds, including surgical incisions, burns, and traumatic injuries. Understanding the molecular mechanisms underlying hypertrophic scar formation is crucial for developing effective therapeutic strategies to prevent or minimize scarring.

The initial phase of hypertrophic scar formation involves an inflammatory response that is critical for wound healing. Inflammatory cytokines, particularly TGF-β, play a pivotal role in this process. TGF-β is secreted by various cell types, including platelets and macrophages, and acts on fibroblasts to promote their proliferation and differentiation into myofibroblasts, which are responsible for collagen synthesis (Deng et al., 2018, pp. 1-12; Xiao et al., 2015, pp. 485-495). The overexpression of TGF-β1 has been closely associated with hypertrophic scar formation, leading to an imbalance in collagen production and degradation (Xiao et al., 2015, pp. 485-495; Li et al., 2016, pp. 326-334). This dysregulation results in excessive deposition of ECM components, particularly collagen types I and III, which are hallmarks of hypertrophic scars (Li et al., 2014, pp.903-911; Li et al., 2016, pp. 326-334).

Fibroblasts are the primary effector cells in hypertrophic scar formation. In response to TGF-β signaling, fibroblasts undergo a phenotypic transformation into myofibroblasts, characterized by increased contractility and collagen production (Xiao et al., 2019, pp. 5989-6000; Deng et al., 2021, pp. 1221-1231). The persistence of myofibroblasts in the wound site is a critical factor contributing to the development of hypertrophic scars. Under normal circumstances, myofibroblasts undergo apoptosis after the wound healing process is complete; however, in hypertrophic scars, their survival is prolonged, leading to continued collagen deposition (Aydoğmuş et al., 2017, pp. 12-17).

The abnormal proliferation and survival of fibroblasts are influenced by various signaling pathways, including the PI3K/AKT and MAPK pathways, which are activated by growth factors such as PDGF and FGF (Ma et al., 2022, pp. 274-284; Wang et al., 2019, pp. 3668-3678). In addition to fibroblast activity, the role of the ECM in hypertrophic scar formation cannot be overlooked. The ECM provides structural support to tissues and regulates cellular behavior. In hypertrophic scars, the ECM is characterized by an abnormal composition and organization, with increased levels of fibronectin and collagen fibers that are densely packed and disorganized (Shibuya et al., 2022, pp. 1-21; Sidgwick and Bayat, 2011, pp. 141-152). This altered ECM environment not only supports fibroblast proliferation but also contributes to the mechanical properties of the scar, affecting its tensile strength and elasticity (Sidgwick and Bayat, 2011, pp. 141-152). The balance between MMPs and their inhibitors (TIMPs) is crucial for ECM remodeling; an imbalance can lead to excessive collagen

accumulation, further exacerbating hypertrophic scar formation (Bikash and Sarkar, 2023, pp. 1191-1196).

The vascular component of hypertrophic scars is also significant. Angiogenesis is often enhanced in hypertrophic scars, contributing to their characteristic redness and swelling (Kwak et al., 2016, pp. 491-497). VEGF is a key mediator of angiogenesis, and its expression is elevated in hypertrophic scars (Kwak et al., 2016, pp. 491-497). The increased vascularity not only supports the metabolic demands of the proliferating fibroblasts but also plays a role in the inflammatory response, perpetuating the cycle of scar formation (Feng et al., 2019, pp. 1-7).

6.2. Keloid Formation

Keloid formation is a complex and multifactorial process characterized by the excessive proliferation of fibroblasts and the abnormal deposition of ECM components, particularly collagen. Keloids typically arise at the site of skin injury, such as surgical incisions, trauma, or burns, and are distinguished from hypertrophic scars by their tendency to extend beyond the original wound margins. Understanding the molecular mechanisms underlying keloid formation is crucial for developing effective therapeutic strategies to manage this condition.

The pathogenesis of keloids involves a dysregulated wound healing response, where the balance between collagen synthesis and degradation is disrupted. One of the key players in this process is TGF-β, which is known to be elevated in keloid tissues. TGF-β promotes fibroblast proliferation and differentiation into myofibroblasts, leading to increased collagen production (Kim et al., 2021, pp. 10765; Zhai et al., 2017, pp. 3467-3472). The TGF-β/SMAD signaling pathway is particularly important in keloid formation, as it regulates the expression of various ECM proteins and modulates fibroblast activity (Kim et al., 2021, pp. 10765; Zhai et al., 2017, pp. 3467-3472).

In keloids, the overexpression of TGF-β1 has been linked to the excessive accumulation of collagen types I and III, contributing to the thick and fibrous nature of keloid scars (He et al., 2017, pp. 1-8; Hunasgi et al., 2013, pp. 116). In addition to TGF-β, other growth factors and cytokines play significant roles in keloid pathogenesis. For instance, insulin-like growth factor-1 (IGF-1) has been shown to enhance fibroblast proliferation and collagen synthesis in keloid fibroblasts (Hu et al., 2014, pp. 822-828). Furthermore, the involvement of inflammatory mediators, such as interleukin-6 (IL-6) and VEGF, has been documented in keloid formation, as they promote angiogenesis and inflammation, further exacerbating the fibrotic response (Seoudy et al., 2022, pp. 38-45; Wu et al., 2020, pp. 1-11).

The ECM composition in keloids is markedly different from that of normal skin and hypertrophic scars. Keloids exhibit a higher density of collagen fibers, particularly type I collagen, which is organized in a disorganized manner compared to the more structured arrangement seen in normal scars (He et al., 2017, pp. 1-8; Jin et al., 2019, pp. 1001-1010). The presence of myofibroblasts, which express alpha-smooth muscle actin (α-SMA), is also a distinguishing feature of keloids, as these cells contribute to the contractile properties of the scar tissue (Hunasgi et al., 2013, pp. 116). The abnormal ECM environment not only supports fibroblast proliferation but also influences the mechanical properties of the keloid, affecting its tensile strength and elasticity (Butzelaar et al., 2017, pp. 758-766; Hahn et al., 2013, pp. 530-544).

Recent research has highlighted the role of non-coding RNAs, particularly miRNAs and long non-coding RNAs (lncRNAs), in the regulation of keloid formation. For example, lncRNA HOXA11-AS has been implicated in promoting type I collagen synthesis and stimulating keloid

formation by sponging miR-124-3p, thereby activating the Smad5 signaling pathway (Jin et al., 2019, pp. 1001-1010). Similarly, miR-200b has been shown to inhibit fibroblast proliferation and promote apoptosis in keloid fibroblasts, suggesting that targeting these non-coding RNAs may offer new therapeutic avenues for keloid management (Yang et al., 2020, pp. 1995-2002; Li, 2023, pp. 1610-1619).

The immune response also plays a critical role in keloid formation. Studies have shown that keloids are associated with an increased presence of inflammatory cells, including macrophages and mast cells, which release cytokines that promote fibroblast activity and collagen deposition (Seoudy et al., 2022, pp. 38-45; Wu et al., 2020, pp. 1-11). The balance between M1 and M2 macrophages is particularly important, as M2 macrophages are known to facilitate tissue repair and fibrosis, while M1 macrophages are associated with inflammation (Seoudy et al., 2022, pp. 38-45). This dysregulation of the immune response can contribute to the chronic inflammation observed in keloid lesions. Mechanical factors, such as tension and stretching of the skin, have also been implicated in keloid formation. Research suggests that mechanical stress can activate signaling pathways that promote fibroblast proliferation and ECM synthesis, leading to the development of keloids (Ogawa et al., 2012, pp. 149-157). This highlights the importance of considering the mechanical environment in the management of keloids, as reducing tension on the scar tissue may help mitigate its progression.

7. POSTOPERATIVE WOUND HEALING AND SCAR FORMATION

Postoperative wound healing and scar formation are critical aspects of surgical recovery that significantly impact patient outcomes and satisfaction. The healing process involves a series of biological events that can lead to various types of scars, including hypertrophic scars and keloids. Understanding the mechanisms of wound healing and the factors influencing scar formation is essential for optimizing surgical techniques and postoperative care.

Several factors can influence the quality of wound healing and scar formation. Surgical techniques, such as the type of incision and closure method, can significantly impact scar outcomes. For instance, the use of intradermal sutures has been shown to reduce the incidence of hypertrophic scars compared to traditional suturing techniques (Wihastyoko and Wuryanjono, 2022, pp. 24-29). Additionally, the tension on the wound edges during healing can affect scar formation; higher tension is associated with an increased risk of hypertrophic scars (Niederstätter et al., 2021, pp. 45).

The timing and type of postoperative interventions also play a crucial role in scar management. Early postoperative treatments, such as the application of silicone gel sheets or the use of fractional laser therapy, have been shown to improve scar outcomes by promoting collagen remodeling and reducing scar thickness (Lee et al., 2013, pp. 1190-1196; Al-Marzouqi et al., 2022, pp. 231-238). For example, fractional carbon dioxide lasers have been effective in treating surgical scars by enhancing collagen remodeling and improving skin texture (Lee et al., 2013, pp. 1190-1196; Al-Marzouqi et al., 2022, pp. 231-238).

Patient-related factors, including age, skin type, and genetic predisposition, can also influence scar formation. Individuals with darker skin types are at a higher risk of developing hypertrophic scars and keloids due to differences in the inflammatory response and collagen metabolism (Surakunprapha et al., 2020, pp. 3883). Furthermore, psychological factors, such

as body image perception and anxiety related to scarring, can impact patient satisfaction with surgical outcomes (Shorka et al., 2021, pp. 2605-2611).

In addition to these factors, the use of adjunctive therapies, such as platelet-rich plasma (PRP) injections and autologous fat grafting, has gained attention in recent years for their potential to enhance wound healing and improve scar appearance (Li et al., 2020, pp. 1-11; Al-Marzouqi et al., 2022, pp. 231-238). PRP, rich in growth factors, can stimulate fibroblast activity and promote collagen synthesis, while fat grafting can provide volume and improve the contour of depressed scars (Li et al., 2020, pp. 1-11; Al-Marzouqi et al., 2022, pp. 231-238).

8. SCAR TREATMENT

Scar treatment is a critical aspect of postoperative care, particularly for patients who undergo surgical procedures that may lead to hypertrophic scars or keloids. The management of scars involves a variety of therapeutic options, including intralesional injections, laser treatments, and topical therapies. Each treatment modality has its own mechanisms of action, efficacy, and indications, which are essential for tailoring interventions to individual patient needs.

8.1. Intralesional Injections

Intralesional injections of corticosteroids, particularly triamcinolone acetonide, have been a cornerstone in the treatment of hypertrophic scars and keloids. These injections work by reducing collagen synthesis and promoting collagen degradation, thereby softening and flattening the scar tissue (Waibel et al., 2013, pp. 135-140; Song et al., 2018, pp. 874-878). Studies have shown that early intervention with intralesional corticosteroids can significantly improve scar outcomes, especially when administered during the early stages of scar formation (Song et al., 2018, pp. 874-878). However, while corticosteroids can effectively reduce scar height and symptoms such as itching and pain, they may not significantly narrow the width of hypertrophic scars (On et al., 2015, pp. 479-484). In addition to corticosteroids, other intralesional agents such as 5-fluorouracil and bleomycin have been explored for their efficacy in treating keloids and hypertrophic scars. These agents can inhibit fibroblast proliferation and collagen production, offering alternative options for patients who may not respond to corticosteroids (Perdanasari et al., 2015, pp. 3; Zhang et al., 2018, pp. 1-12). The combination of intralesional injections with other modalities, such as laser therapy, has also been investigated to enhance treatment outcomes (Krakowski et al., 2014, pp. 1700-1705).

8.2. Laser Therapy

Laser therapy has emerged as a promising treatment for scar management, with various types of lasers being utilized for different scar types. Ablative fractional lasers, such as carbon dioxide (CO_2) lasers, are particularly effective for treating hypertrophic scars and keloids by promoting collagen remodeling and improving skin texture (Tan et al., 2020, pp. 450-457; Kim et al., 2014, pp. 973-978). Fractional laser treatments create micro-injuries in the skin, stimulating the body's natural healing response and leading to the production of new collagen (Tan et al., 2020, pp. 450-457). Studies have demonstrated that early intervention with fractional lasers can improve the appearance of surgical scars, making them a valuable tool in postoperative scar management (Shin et al., 2021, pp. 347-352; Zhang et al., 2019, pp. 137-148).

Non-ablative lasers, such as pulsed dye lasers (PDL), are also used to treat hypertrophic scars by targeting the vascular component of the scar tissue. These lasers can reduce redness and improve the overall appearance of scars without significant downtime (Kim et al., 2014, pp. 973-978; Kauvar et al., 2019, pp. 125-136). The choice between ablative and non-ablative lasers depends on the scar's characteristics, the patient's skin type, and the desired outcomes.

Cryotherapy, particularly when combined with laser treatment, has also been highlighted as an effective approach for managing keloids. The cooling effect of cryotherapy can induce localized tissue destruction and reduce vascularity, which may contribute to scar flattening (Agarwal et al., 2015, pp. 597-604; Choi et al., 2018, pp. 32-37). the CROSS (Chemical Reconstruction of Skin Scars) technique, which employs high concentrations of trichloroacetic acid (TCA), has been effectively used for treating atrophic acne scars, demonstrating significant improvement in scar morphology (Makwana et al., 2022). This method, alongside subcision and microneedling, represents a comprehensive approach to managing various scar types, particularly in patients with complex scar presentations.

8.3. Topical Treatments

Topical treatments are another important aspect of scar management. Silicone gel sheets and silicone ointments have been widely used to prevent and treat hypertrophic scars. These products create a protective barrier over the scar, maintaining hydration and reducing collagen production (Chanprapaph et al., 2012). Studies have shown that silicone therapy can lead to significant improvements in scar appearance, particularly when used early in the healing process (Chanprapaph et al., 2012). Additionally, natural extracts, such as onion extract, have been investigated for their potential benefits in scar treatment, although the evidence supporting their efficacy is less robust compared to silicone products (Chanprapaph et al., 2012).

8.4. Combination Therapies

Combination therapies are increasingly being recognized as effective strategies for scar management. For example, combining laser treatments with intralesional corticosteroids has shown synergistic effects in reducing scar height and improving texture (Krakowski et al., 2014, pp. 1700-1705; Tan et al., 2020, pp. 450-457). Furthermore, the use of pressure therapy in conjunction with other modalities can enhance scar outcomes by applying consistent pressure to the scar tissue, which is known to help flatten hypertrophic scars (Qiu et al., 2015, pp. 2787-2791).

8.5. Surgical Treatment

Surgical intervention remains a viable option for scar treatment, particularly in cases of severe hypertrophic scars or keloids that do not respond to conservative measures. Surgical excision, when combined with postoperative therapies such as corticosteroid injections or laser treatment, can significantly reduce recurrence rates and improve aesthetic outcomes (El-Tahlawi and Mohamed, 2023, pp. 49-55; Park et al., 2011). However, it is crucial to recognize that surgical approaches alone may not suffice, as the recurrence of keloids post-excision is common, necessitating a multimodal treatment strategy (Park et al., 2011; Mohammadi et al., 2018, pp. 326-331).

8.6. Emerging Therapies

Emerging therapies are also being explored for their potential in scar treatment. For instance, the use of PRP has gained attention for its ability to promote healing and reduce scar

formation through the release of growth factors (Li et al., 2020, pp. 1-11). Additionally, novel approaches such as the application of mesenchymal stem cells and gene therapy are being investigated for their potential to improve scar outcomes (Wang et al., 2019, pp. 3668-3678; Yun et al., 2019,).

The CROSS (Chemical Reconstruction of Skin Scars) technique, which employs high concentrations of trichloroacetic acid (TCA), has been effectively used for treating atrophic acne scars, demonstrating significant improvement in scar morphology (Makwana et al., 2022, pp. 34-38). This method, alongside subcision and microneedling, represents a comprehensive approach to managing various scar types, particularly in patients with complex scar presentations.

Recent studies have explored the potential of targeting specific molecular pathways to mitigate hypertrophic scar formation. For instance, the use of anti-VEGF therapies has shown promise in reducing scar formation by inhibiting excessive angiogenesis (Kwak et al., 2016, pp. 491-497). Additionally, agents that modulate TGF-β signaling, such as small molecule inhibitors, have been investigated for their ability to reduce fibroblast activity and collagen deposition (Igarashi et al., 2015, pp. e0125295). Furthermore, the application of topical treatments, such as silicone gel sheets, has been shown to improve scar appearance by providing a moist environment and reducing tension on the scar (Eisendle et al., 2019, pp. 257-260; Gauglitz, 2013, pp. 103).

The psychological impact of scars on patients cannot be overlooked. Scarring can lead to significant emotional distress, affecting self-esteem and quality of life. Therefore, a comprehensive treatment plan should not only focus on the physical aspects of scar management but also consider the psychosocial implications. Counseling and support groups may be beneficial adjuncts to traditional treatment modalities, helping patients cope with the emotional burden of scarring (Sidgwick et al., 2015, pp. 461-477).

9. CONCLUSION

Wound healing is a complex and dynamic process that is influenced by a multitude of factors, including growth factors, cellular interactions, and the extracellular matrix. The molecular mechanisms of wound healing involve a complex interplay of various signaling pathway, each phase of healing is characterized by specific molecular events that are crucial for effective tissue repair.

Scar formation is a complex process involving a dynamic interplay between inflammatory responses, fibroblast activity, ECM remodeling, and mechanical forces. Hypertrophic scars and keloids represent the most common forms of abnormal scarring, while atrophic scars, contracture scars, and acne scars highlight the diverse nature of scar tissue.

Hypertrophic scar formation is a multifactorial process driven by an interplay of inflammatory responses, fibroblast activity, ECM remodeling, and angiogenesis. Keloid formation is also a multifactorial process driven by a combination of genetic, molecular, and environmental factors. The dysregulation of fibroblast activity, abnormal ECM deposition, and the influence of inflammatory and mechanical factors all contribute to the pathogenesis of keloids.

The scar treatment has various treatment choices such as intralesional injections, laser therapy, topical treatments, combination therapies, surgical treatment and emerging therapies. The choice of treatment should be individualized based on the type of scar, the patient's skin characteristics, and the timing of intervention.

10. REFERENCES

Agarwal, N., Gupta, L., Khare, A. K., Kuldeep, C. M., Mittal, A. (2015). Therapeutic response of 70% trichloroacetic acid cross in atrophic acne scars. Dermatologic Surgery, 41(5), 597-604. https://doi.org/10.1097/dss.0000000000000355

Al-Marzouqi, H., Nagy, E., Sair, M., and Mabrouk, A. (2022). The efficacy of low energy fractional carbon dioxide laser therapy in management of post-surgical hypertrophic scars. The Egyptian Journal of Plastic and Reconstructive Surgery, 46(3), 231-238. https://doi.org/10.21608/ejprs.2022.254701

Aydoğmuş, S., Kelekci, K., Şengül, M., Demirel, E., Karaca, Ş., Desdicioğlu, R., Kelekci, S. (2017). Factors affecting the development of scar formation in abdominal surgery performed for gynecologic and obstetric conditions. Turkderm, 51(1), 12-17. https://doi.org/10.4274/turkderm.58751

Batool, Z., Muhammad, G., Iqbal, M., Aslam, M., Raza, M., Sajjad, N., Abdullah, M., Akhtar, N., Syed, A., Elgorban, A., Al-Rejaie, S., Shafiq, Z. (2022). Hydrogel assisted synthesis of gold nanoparticles with enhanced microbicidal and in vivo wound healing potential. Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-10495-3

Bikash, C. and Sarkar, R. (2023). Topical management of acne scars: the uncharted terrain. Journal of Cosmetic Dermatology, 22(4), 1191-1196. https://doi.org/10.1111/jocd.15584

Bitar, M. and Al-Mulla, F. (2012). ROS constitute a convergence nexus in the development of igf1 resistance and impaired wound healing in a rat model of type 2 diabetes. Disease Models and Mechanisms, 5(3), 375-388. https://doi.org/10.1242/dmm.007872

Butzelaar, L., Niessen, F., Talhout, W., Schooneman, D., Ulrich, M., Beelen, R., … and Molen, A. (2017). Different properties of skin of different body sites: the root of keloid formation?. Wound Repair and Regeneration, 25(5), 758-766. https://doi.org/10.1111/wrr.12574

Chanprapaph, K., Tanrattanakorn, S., Wattanakrai, P., Wongkitisophon, P., and Vachiramon, V. (2012). Effectiveness of onion extract gel on surgical scars in asians. Dermatology Research and Practice, 2012, 1-6. https://doi.org/10.1155/2012/212945

Choi, J., Jun, J. H., Kim, J. H., Sung, H. J., Lee, J. H. (2014). Synergistic effect of interleukin-6 and hyaluronic acid on cell migration and erk activation in human keratinocytes. Journal of Korean Medical Science (Suppl 3), 29, 210-126. https://doi.org/10.3346/jkms.2014.29.s3.s210

Choi, Y. S., Khan, G., Nam, S. M., Park, E. S. (2018). Successful treatment of post-traumatic elbow scar contracture using combined approach of surgical release & early fractional laser resurfacing. Medical Lasers, 7(1), 32-37. https://doi.org/10.25289/ml.2018.7.1.32

Darby, I. and Desmoulière, A. (2020). Scar formation: cellular mechanisms., 19-26. https://doi.org/10.1007/978-3-030-44766-3_3

Deng, X., Chen, Q., Qiang, L., Chi, M., Xie, N., Wu, Y., Yao, M., Zhao, D., Ma, J., Zhang, N., Xie, Y. (2018). Development of a porcine full-thickness burn hypertrophic scar model and investigation of the effects of shikonin on hypertrophic scar remediation. Frontiers in Pharmacology, 9, 1-12. https://doi.org/10.3389/fphar.2018.00590

Deng, X., Zhao, F., Zhao, D., Zhang, Q., Zhu, Y., Chen, Q., Xie, Y. (2021). Oxymatrine promotes hypertrophic scar repair through reduced human scar fibroblast viability, collagen and induced apoptosis via autophagy inhibition. International Wound Journal, 19(5), 1221-1231. https://doi.org/10.1111/iwj.13717

Donovan, J., Xu, S., Norman, J., Abraham, D. (2013). Platelet-derived growth factor alpha and beta receptors have overlapping functional activities towards fibroblasts. Fibrogenesis & Tissue Repair, 6(1), 1-9. https://doi.org/10.1186/1755-1536-6-10

Duan, M., Zhang, Y., Zhang, H., Meng, Y., Qian, M., Zhang, G. (2020). Epidermal stem cell-derived exosomes promote skin regeneration by downregulating transforming growth factor-β1 in wound healing. Stem Cell Research & Therapy, 11(1), 1-11. https://doi.org/10.1186/s13287-020-01971-6

Dwivedi, C., Pandey, H., Pandey, A., Patil, S., Ramteke, P., Laux, P., Luch, A., Singh, A. (2019). In vivo biocompatibility of electrospun biodegradable dual carrier (antibiotic + growth factor) in a mouse model—implications for rapid wound healing. Pharmaceutics, 11(4), 1-19. https://doi.org/10.3390/pharmaceutics11040180

Ebrahiminaseri, A., Sadeghizadeh, M., Moshaii, A., Asgaritarghi, G., and Safari, Z. (2021). Combination treatment of dendrosomal nanocurcumin and low-level laser therapy develops proliferation and migration of mouse embryonic fibroblasts and alter tgf-β, vegf, tnf-α and il-6 expressions involved in wound healing process. Plos One, 16(5), 1-23. e0247098. https://doi.org/10.1371/journal.pone.0247098

Eisendle, K., Pichler, M., Luca, J., Thuile, T. (2019). Use of self-adherent silicone sheets in a pediatric burn patient: a case report and instructions for use. Pediatric Dermatology, 37(1), 257-260. https://doi.org/10.1111/pde.14017

El-Tahlawi, S. and Mohamed, B. (2023). Intralesional triamcinolone acetonide in the treatment of keloids and hypertrophic scars. Fayoum University Medical Journal, 11(1), 49-55. https://doi.org/10.21608/fumj.2023.278472

Fabbrocini, G., Annunziata, M., D'Arco, V., Vita, V., Lodi, G., Mauriello, M., Monfrecola, G. (2010). Acne scars: pathogenesis, classification and treatment. Dermatology Research and Practice, 2010(1), 1-13. https://doi.org/10.1155/2010/893080

Feng, Y., Sun, Z., Liu, S., Wu, J., Zhao, B., Lv, G., Zhou, X. (2019). Direct and indirect roles of macrophages in hypertrophic scar formation. Frontiers in Physiology, 10, 1-7. https://doi.org/10.3389/fphys.2019.01101

Finnerty, C., Jeschke, M., Branski, L., Barret, J., Dziewulski, P., Herndon, D. (2016). Hypertrophic scarring: the greatest unmet challenge after burn injury. The Lancet, 388(10052), 1427-1436. https://doi.org/10.1016/s0140-6736(16)31406-4

Gauglitz, G. (2013). Management of keloids and hypertrophic scars: current and emerging options. Clinical Cosmetic and Investigational Dermatology, 103. https://doi.org/10.2147/ccid.s35252

Gaur, N. (2018). A comparative analysis of carbon dioxide laser technique and derma roller therapy in post-acne scars patients. International Journal of Surgery Science, 2(1), 48-50. https://doi.org/10.33545/surgery.2018.v2.i1a.888

Gisquet, H., Liu, H., Blondel, W., Leroux, A., Latarche, C., Merlin, J., Guillemin, F. (2011). Intradermal tacrolimus prevent scar hypertrophy in a rabbit ear model: a clinical, histological and spectroscopical analysis. Skin Research and Technology, 17(2), 160-166. https://doi.org/10.1111/j.1600-0846.2010.00479.x

Guan, Y., Niu, H., Liu, Z., Dang, Y., Shen, J., Zayed, M., Ma, L., Guan, J. (2021). Sustained oxygenation accelerates diabetic wound healing by promoting epithelialization and angiogenesis and decreasing inflammation. Science Advances 7(35), 1-14. https://doi.org/10.1126/sciadv.abj0153

Gurtner, G., Dauskardt, R., Wong, V., Bhatt, K., Wu, K., Vial, I., Longaker, M. (2011). Improving cutaneous scar formation by controlling the mechanical environment. Annals of Surgery Open, 254(2), 217-225. https://doi.org/10.1097/sla.0b013e318220b159

Hahn, J., Glaser, K., McFarland, K., Aronow, B., Boyce, S., Supp, D. (2013). Keloid-derived keratinocytes exhibit an abnormal gene expression profile consistent with a distinct causal role in keloid pathology. Wound Repair and Regeneration, 21(4), 530-544. https://doi.org/10.1111/wrr.12060

He, T., Bai, X., Yang, L., Fan, L., Li, Y., Su, L., Gao, J., Han, S., Hu, D. (2015). Loureirin b inhibits hypertrophic scar formation via inhibition of the tgf-β1-erk/jnk pathway. Cellular Physiology and Biochemistry, 37(2), 666-676. https://doi.org/10.1159/000430385

He, Y., Deng, Z., Alghamdi, M., Lü, L., Fear, M., and He, L. (2017). From genetics to epigenetics: new insights into keloid scarring. Cell Proliferation, 50(2), 1-8. https://doi.org/10.1111/cpr.12326

He, J., Fang, B., Shan, S., Xie, Y., Wang, C., Zhang, Y., Zhang, X., Li, Q. (2021). Mechanical stretch promotes hypertrophic scar formation through mechanically activated cation channel piezo1. Cell Death and Disease, 12(3), 1-13. https://doi.org/10.1038/s41419-021-03481-6

Hesketh, M., Sahin, K., West, Z., Murray, R. (2017). Macrophage phenotypes regulate scar formation and chronic wound healing. International Journal of Molecular Sciences, 18(7), 1-10. https://doi.org/10.3390/ijms18071545

Hsiao, C., Cheng, H. W., Huang, C. M., Li, H. R., Ou, M. H., Huang, J. R., Khoo, K., Yu, W. H., Chen, Y., Wang, Y., Chiou, A., Kuo, J. (2017). Fibronectin in cell adhesion and migration via n-glycosylation. Oncotarget 8(41), 70653-70668. https://doi.org/10.18632/oncotarget.19969

Hu, Z., Tang, B., Guo, D., Zhang, J., Liang, Y., Ma, D., Zhu, J. (2014). Expression of insulin-like growth factor-1 receptor in keloid and hypertrophic scar. Clinical and Experimental Dermatology, 39(7), 822-828. https://doi.org/10.1111/ced.12407

Huang, C., Murphy, G., Akaishi, S., Ogawa, R. (2013). Keloids and hypertrophic scars. Plastic and Reconstructive Surgery Global Open, 1(4), e25. https://doi.org/10.1097/gox.0b013e31829c4597

Huang, L., Chen, D., Xu, Q., Zheng, Z., Dai, X. (2020). The use of the scar cosmesis assessment and rating scale to evaluate the cosmetic outcomes of totally thoracoscopic cardiac surgery. Journal of Cardiothoracic Surgery, 15(1). https://doi.org/10.1186/s13019-020-01294-w

Hunasgi, S., Koneru, A., Vanishree, M., Ravikumar, S. (2013). Keloid: a case report and review of pathophysiology and differences between keloid and hypertrophic scars. Journal of Oral and Maxillofacial Pathology, 17(1), 116. https://doi.org/10.4103/0973-029x.110701

Igarashi, J., Fukuda, N., Inoue, T., Nakai, S., Saito, K., Fujiwara, K., Soma, M. (2015). Preclinical study of novel gene silencer pyrrole-imidazole polyamide targeting human tgf-β1 promoter for hypertrophic scars in a common marmoset primate model. Plos One, 10(5), e0125295. https://doi.org/10.1371/journal.pone.0125295

İnan, Z., Saraydın, S. (2013). Investigation of the wound healing effects of chitosan on FGFR3 and VEGF immunlocalization in experimentally diabetic rats. International Journal of Biomedical Materials Research, 1(1), 1-8. https://doi.org/10.11648/j.ijbmr.20130101.11

Jin, J., Zhai, H., Jia, Z., and Luo, X. (2019). Long non-coding rna hoxa11-as induces type I collagen synthesis to stimulate keloid formation via sponging mir-124-3p and activation of smad5 signaling. Ajp Cell Physiology, 317(5), C1001-C1010. https://doi.org/10.1152/ajpcell.00319.2018

Kauvar, A., Kubicki, S., Suggs, A., Friedman, P. (2019). Laser therapy of traumatic and surgical scars and an algorithm for their treatment. Lasers in Surgery and Medicine, 52(2), 125-136. https://doi.org/10.1002/lsm.23171

Kieran, I., Knock, A., Bush, J., So, K., Metcalfe, A., Hobson, R., Ferguson, M. (2013). Interleukin-10 reduces scar formation in both animal and human cutaneous wounds: results of two preclinical and phase ii randomized control studies. Wound Repair and Regeneration, 21(3), 428-436. https://doi.org/10.1111/wrr.12043

Kim, D., Ryu, H., Choi, J., Ahn, H., Kye, Y., and Seo, S. (2014). A comparison of the scar prevention effect between carbon dioxide fractional laser and pulsed dye laser in surgical scars. Dermatologic Surgery, 40(9), 973-978. https://doi.org/10.1097/01.dss.0000452623.24760.9c

Kim, S., Lee, S., Yi, S., Jun, S., Yi, Y., Nagar, H., Oh, S. (2021). Tauroursodeoxycholic acid decreases keloid formation by reducing endoplasmic reticulum stress as implicated in the pathogenesis of keloid. International Journal of Molecular Sciences, 22(19), 10765. https://doi.org/10.3390/ijms221910765

Kravvas, G. and Al-Niaimi, F. (2017). A systematic review of treatments for acne scarring. part 1: non-energy-based techniques. Scars Burns & Healing, 3, 1-17. https://doi.org/10.1177/2059513117695312

Kwak, D., Bae, T., Kim, W., Kim, H. (2016). Anti-vascular endothelial growth factor (bevacizumab) therapy reduces hypertrophic scar formation in a rabbit ear wounding model. Archives of Plastic Surgery, 43(06), 491-497. https://doi.org/10.5999/aps.2016.43.6.491

Krakowski, A., Goldenberg, A., Eichenfield, L., Murray, J., Shumaker, P. (2014). Ablative fractional laser resurfacing helps treat restrictive pediatric scar contractures. Pediatrics, 134(6), e1700-e1705. https://doi.org/10.1542/peds.2014-1586

Lee, S., Zheng, Z., and Roh, M. (2013). Early postoperative treatment of surgical scars using a fractional carbon dioxide laser: a split-scar, evaluator-blinded study. Dermatologic Surgery, 39(8), 1190-1196. https://doi.org/10.1111/dsu.12228

Li, P., He, Q., and Luo, C. (2014). Overexpression of mir-200b inhibits the cell proliferation and promotes apoptosis of human hypertrophic scar fibroblastsin vitro. The Journal of Dermatology, 41(10), 903-911. https://doi.org/10.1111/1346-8138.12600

Li, P., Li, H., Zhong, L., Sun, Y., Liu, Y., Wu, M., Zhang, L., Kong, Q., Wang, S., Lv, C. (2015). Molecular events underlying maggot extract promoted rat in vivo and human in vitro skin wound healing. Wound Repair and Regeneration 23 (1), 65-73. https://doi.org/10.1111/wrr.12243

Li, J., Chen, L., Cao, C., Yan, H., Zhou, B., Gao, Y., Li, J. (2016). The long non-coding rna lncrna8975-1 is upregulated in hypertrophic scar fibroblasts and controls collagen expression. Cellular Physiology and Biochemistry, 40(1-2), 326-334. https://doi.org/10.1159/000452548

Li, X., Guo, L., Yang, X., Wang, J., Hou, Y., Zhu, S., Liu, Y. (2019). Tgf-β1-induced connexin43 promotes scar formation via the erk/mmp-1/collagen iii pathway. Journal of Oral Rehabilitation, 47(S1), 99-106. https://doi.org/10.1111/joor.12829

Li, K., Nicoli, F., Cui, C., Xi, W., Al-Mousawi, A., Zhang, Z., Zhang, Y. (2020). Treatment of hypertrophic scars and keloids using an intralesional 1470 nm bare-fibre diode laser: a novel efficient minimally-invasive technique. Scientific Reports, 10(1), 1-11. https://doi.org/10.1038/s41598-020-78738-9

Li, S., Li, Y., Wu, Z., Wu, Z., and Fang, H. (2021). Diabetic ferroptosis plays an important role in triggering on inflammation in diabetic wound. Ajp Endocrinology and Metabolism, 321(4), E509-E520. https://doi.org/10.1152/ajpendo.00042.2021

Li, M. (2023). Inhibition of proliferation, migration, and invasion of keloid fibroblasts by mir-183-5p through downregulating egr1. International Journal of Morphology, 41(6), 1610-1619. https://doi.org/10.4067/s0717-95022023000601610

Limandjaja, G., Niessen, F., Scheper, R., Gibbs, S. (2020). Hypertrophic scars and keloids: overview of the evidence and practical guide for differentiating between these abnormal scars. Experimental Dermatology, 30(1), 146-161. https://doi.org/10.1111/exd.14121

Ma, L., Gan, C., Huang, Y., Wang, Y., Luo, G., Wu, J. (2014). Comparative proteomic analysis of extracellular matrix proteins secreted by hypertrophic scar with normal skin fibroblasts. Burns & Trauma, 2(2), 76-83. https://doi.org/10.4103/2321-3868.130191

Ma, F., Shen, J., Zhang, H., Zhang, Z., Yang, A., Xiong, J., Jiang, Y. (2022). A novel lncrna fpasl regulates fibroblast proliferation via the pi3k/akt and mapk signaling pathways in hypertrophic scar. Acta Biochimica Et Biophysica Sinica, 274-284. https://doi.org/10.3724/abbs.2022122

Makwana, J., Vora, D., Soyal, V. (2022). A comparative study of efficacy of fractional co2 laser vs microdermabrasion in treatment of acne scars (total 100 patients). International Journal of Research and Review, 9(1), 34-38. https://doi.org/10.52403/ijrr.20220105

Masi, E., Campos, A., Masi, F., Ratti, M., Ike, I., Masi, R. (2016). The influence of growth factors on skin wound healing in rats. Brazilian Journal of Otorhinolaryngology, 82(5), 512-521. https://doi.org/10.1016/j.bjorl.2015.09.011

Medyukhina, A., Vogler, N., Latka, I., Kemper, S., Böhm, M., Dietzek, B., Popp, J. (2011). Automated classification of healthy and keloidal collagen patterns based on processing of shg images of human skin. Journal of Biophotonics, 4(9), 627-636. https://doi.org/10.1002/jbio.201100028

Mohammadi, A. A., Parand, A., Kardeh, S., Janati, M., and Mohammadi, S. (2018). Efficacy of topical enalapril in treatment of hypertrophic scars. World Journal of Plastic Surgery, 7(3), 326-331. https://doi.org/10.29252/wjps.7.3.326

Morris, M., Allukian, M., Herdrich, B., Caskey, R., Zgheib, C., Xu, J., Liechty, K. (2014). Modulation of the inflammatory response by increasing fetal wound size or interleukin-10 overexpression determines wound phenotype and scar formation. Wound Repair and Regeneration, 22(3), 406-414. https://doi.org/10.1111/wrr.12180

Moura, J., Sørensen, A. E., Leal, E. C., Svendsen, R. P., Carvalho, L., Willemoes, R. J., Jorgensen, P. T., Jenssen, H., Wengel, J., Dalgaard, R. T., Carvalho, E. (2019). Microrna-155 inhibition restores fibroblast growth factor 7 expression in diabetic skin and decreases wound inflammation. Scientific Reports, 9(1), 1-11. https://doi.org/10.1038/s41598-019-42309-4

Natallya, F., Herwanto, N., Prakoeswa, C., Indramaya, D., Rantam, F. (2019). Effective healing of leprosy chronic plantar ulcers by application of human amniotic membrane stem cell secretome gel. Indian Journal of Dermatology, 64(3), 250. https://doi.org/10.4103/ijd.ijd_6_17

Niederstätter, I., Schiefer, J., and Fuchs, P. (2021). Surgical strategies to promote cutaneous healing. Medical Sciences, 9(2), 45. https://doi.org/10.3390/medsci9020045

Noh, K., Liu, X., Zhong, Z., Yang, C., Kim, Y., Lee, G., Choi, K., Kim, K. (2018). Leukocyte-poor platelet-rich plasma-derived growth factors enhance human fibroblast proliferation in vitro. Clinics in Orthopedic Surgery, 10(2), 240-247. https://doi.org/10.4055/cios.2018.10.2.240

Ogawa, R., Okai, K., Tokumura, F., Mori, K., Ohmori, Y., Huang, C., Hyakusoku, H., Akaishi, S. (2012). The relationship between skin stretching/contraction and pathologic scarring: the important role of mechanical forces in keloid generation. Wound Repair and Regeneration, 20(2), 149-157. https://doi.org/10.1111/j.1524-475x.2012.00766.x

On, H., Lee, S., Lee, Y., Chang, H., Park, C., Roh, M. (2015). Evaluating hypertrophic thyroidectomy scar outcomes after treatment with triamcinolone injections and copper bromide laser therapy. Lasers in Surgery and Medicine, 47(6), 479-484. https://doi.org/10.1002/lsm.22375

Ong, C., Khoo, Y., Mukhopadhyay, A., Masilamani, J., Do, D., Lim, I., Phan, T. (2010). Comparative proteomic analysis between normal skin and keloid scar. British Journal of Dermatology, 162(6), 1302-1315. https://doi.org/10.1111/j.1365-2133.2010.09660.x

Palumbo, V., Rizzuto, S., Damiano, G., Fazzotta, S., Gottardo, A., Mazzola, G., Monte, A. (2021). Use of platelet concentrate gel in second-intention wound healing: a case report. Journal of Medical Case Reports, 15(1), 1-7. https://doi.org/10.1186/s13256-020-02649-6

Park, T. H., Seo, S. W., Kim, J. K., Chang, C. H. (2011). Management of chest keloids. Journal of Cardiothoracic Surgery, 6(1). https://doi.org/10.1186/1749-8090-6-49

Perdanasari, A., Torresetti, M., Grassetti, L., Nicoli, F., Zhang, Y., Dashti, T., Lazzeri, D. (2015). Intralesional injection treatment of hypertrophic scars and keloids: a systematic review regarding outcomes. Burns & Trauma, 3. https://doi.org/10.1186/s41038-015-0015-7

Pradhan, M. (2023). The molecular mechanisms involved in the hypertrophic scars post-burn injury. The Yale Journal of Biology and Medicine, 96(4), 549-563. https://doi.org/10.59249/rhuf5686

Prakoeswa, C., Rindiastuti, Y., Wirohadidjojo, Y., Komaratih, E., Dinaryati, A., Lestari, N., Rantam, F. (2020). Resveratrol promotes secretion of wound healing related growth factors of mesenchymal stem cells originated from adult and fetal tissues. Artificial Cells Nanomedicine and Biotechnology, 48(1), 1159-1166. https://doi.org/10.1080/21691401.2020.1817057

Qi, W., Yang, C., Dai, Z., Che, D., Feng, J., Mao, Y., Cheng, R., Wang, Z., He, X., Zhou, T., Gu, X., Yan, L., Yang, X., Ma, J., Gao, G. (2014). High levels of pigment epithelium–derived factor in diabetes impair wound healing through suppression of wnt signaling. Diabetes, 64(4), 1407-1419. https://doi.org/10.2337/db14-1111

Qin, Song, Xie, Y., Gou, Q., Guo, X., Qian, Y., Gou, X. (2017). JAK/STAT3 and Smad3 activities are required for the wound healing properties of *Periplaneta americana* extracts. International Journal of Molecular Medicine, 40 (2), 465-473. https://doi.org/10.3892/ijmm.2017.3040

Qiu, Y., Yang, S., Tan, J., Luo, G., Wang, H., Wu, J. (2015). Process of hypertrophic scar formation. Chinese Medical Journal, 128(20), 2787-2791. https://doi.org/10.4103/0366-6999.167359

Ren, Z., Hou, Y., Ma, S., Yang, T., Li, J., Cao, H., Ji, L. (2014). Effects of ccn3 on fibroblast proliferation, apoptosis and extracellular matrix production. International Journal of Molecular Medicine, 33(6), 1607-1612. https://doi.org/10.3892/ijmm.2014.1735

Rong, S., Li, C., Li, S., Wu, S., Sun, F. (2020). Genetically modified adipose-derived stem cells with matrix metalloproteinase 3 promote scarless cutaneous repair. Dermatologic Therapy, 33(6), 1-8. https://doi.org/10.1111/dth.14112

Ruthenborg, R. J., Ban, J. J., Wazir, A., Takeda, N., Kim, J. (2014). Regulation of wound healing and fibrosis by hypoxia and hypoxia-inducible factor-1. Molecules and Cells 37(9), 637-643. https://doi.org/10.14348/molcells.2014.0150

Schouten, H., Nieuwenhuis, M., Schans, C., Niemeijer, A., Zuijlen, P. (2023). Considerations in determining the severity of burn scar contractures with focus on the knee joint. Journal of Burn Care & Research, 44(4), 810-816. https://doi.org/10.1093/jbcr/irad016

Seoudy, W., Dien, S., Reheem, T., Elfangary, M., Erfan, M. (2022). Macrophages of the m1 and m2 types play a role in keloids pathogenesis. International Wound Journal, 20(1), 38-45. https://doi.org/10.1111/iwj.13834

Sidgwick, G. and Bayat, A. (2011). Extracellular matrix molecules implicated in hypertrophic and keloid scarring. Journal of the European Academy of Dermatology and Venereology, 26(2), 141-152. https://doi.org/10.1111/j.1468-3083.2011.04200.x

Sidgwick, G. P., McGeorge, D., and Bayat, A. (2015). A comprehensive evidence-based review on the role of topicals and dressings in the management of skin scarring. Archives of Dermatological Research, 307(6), 461-477. https://doi.org/10.1007/s00403-015-1572-0

Shi, H., Lin, C., Lin, B., Wang, Z., Zhang, H., Wu, F., Xiao, J. (2013). The anti-scar effects of basic fibroblast growth factor on the wound repair in vitro and in vivo. Plos One, 8(4), 1-10e59966. https://doi.org/10.1371/journal.pone.0059966

Shibuya, Y., Okawa, H., Kondo, T., Khalil, D., Wang, L., Roca, Y., Jarrahy, R. (2022). Therapeutic downregulation of neuronal PAS domain 2 (npas2) promotes surgical skin wound healing. Elife, 11, 1-21. https://doi.org/10.7554/elife.71074

Shin, H., Suk, S., Chae, S., Yoon, K., Kim, J. (2021). Early postoperative treatment of mastectomy scars using a fractional carbon dioxide laser: a randomized, controlled, split-scar, blinded study. Archives of Plastic Surgery, 48(4), 347-352. https://doi.org/10.5999/aps.2020.02495

Shorka, D., Yemini, N., Shushan, G., Tokar, L., Benbenishty, J., and Woloski-Wruble, A. (2021). Body image and scar assessment: a longitudinal cohort analysis of cardiothoracic, neurosurgery and urology patients. Journal of Clinical Nursing, 31(17-18), 2605-2611. https://doi.org/10.1111/jocn.16083

Song, H., Tan, J., Fu, Q., Huang, L., Ao, M. (2018). Comparative efficacy of intralesional triamcinolone acetonide injection during early and static stage of pathological scarring. Journal of Cosmetic Dermatology, 18(3), 874-878. https://doi.org/10.1111/jocd.12690

Sun, M., He, Y., Zhou, T., Zhang, P., Gao, J., Lu, F. (2017). Adipose extracellular matrix/stromal vascular fraction gel secretes angiogenic factors and enhances skin wound healing in a murine model. Biomed Research International, 2017, 1-11. https://doi.org/10.1155/2017/3105780

Surakunprapha, P., Winaikosol, K., Chowchuen, B., Punyavong, P., Jenwitheesuk, K., and Jenwitheesuk, K. (2020). A prospective randomized double-blind study of silicone gel plus herbal extracts versus placebo in pre-sternal hypertrophic scar prevention and amelioration. Heliyon, 6(5), e03883. https://doi.org/10.1016/j.heliyon.2020.e03883

Suryanarayan, S., Budamakuntla, L., Khadri, S., and Sarvajnamurthy, S. (2014). Efficacy of autologous platelet-rich plasma in the treatment of chronic nonhealing leg ulcers. Plastic and Aesthetic Research, 1(2), 65-69. https://doi.org/10.4103/2347-9264.139703

Süntar, İ, Çetinkaya, S., Panieri, E., Saha, S., Buttari, B., Saso, L. (2021). Regulatory role of nrf2 signaling pathway in wound healing process. Molecules 26(9), 2424. https://doi.org/10.3390/molecules26092424

Takaya, K., Aramaki-Hattori, N., Sakai, S., Okabe, K., Asou, T., Kishi, K. (2022). Decorin inhibits dermal mesenchymal cell migration and induces scar formation. Plastic and Reconstructive Surgery Global Open, 10(4), e4245. https://doi.org/10.1097/gox.0000000000004245

Tan, J., Zhou, J., Huang, L., Fu, Q., Ao, M., Yuan, L., Luo, G. (2020). Hypertrophic scar improvement by early intervention with ablative fractional carbon dioxide laser treatment. Lasers in Surgery and Medicine, 53(4), 450-457. https://doi.org/10.1002/lsm.23301

Tan, Y., Zhang, M., Kong, Y., Zhang, F., Wang, Y., Huang, Y., Song, W., Li, Z., Hou, L., Liang, L., Guo, X., Liu, Q., Feng, Y., Zhang, C., Fu, X., Huang, S. (2023). Fibroblasts and endothelial cells interplay drives hypertrophic scar formation: insights from in vitro and in vivo models. Bioengineering & Translational Medicine, 9(2), 1-15. https://doi.org/10.1002/btm2.10630

Tripathi, S., Soni, K., Agrawal, P., Gour, V., Mondal, R., Soni, V. (2020). Hypertrophic scars and keloids: a review and current treatment modalities. Biomedical Dermatology, 4(1), 1-11. https://doi.org/10.1186/s41702-020-00063-8

Volk, S., Wang, Y., Mauldin, E., Liechty, K., Adams, S. (2011). Diminished type iii collagen promotes myofibroblast differentiation and increases scar deposition in cutaneous wound healing. Cells Tissues Organs, 194(1), 25-37. https://doi.org/10.1159/000322399

Vukelic, S., Stojadinović, O., Pastar, I., Rabach, M., Krzyzanowska, A., Lebrun, E., Davis, S. C., Resnik, S., Brem, H., Tomic-Canic, M. (2011). Cortisol synthesis in epidermis is induced by IL-1 and tissue injury. Journal of Biological Chemistry, 286 (12), 10265-10275. https://doi.org/10.1074/jbc.m110.188268

Waibel, J., Wulkan, A., and Shumaker, P. (2013). Treatment of hypertrophic scars using laser and laser assisted corticosteroid delivery. Lasers in Surgery and Medicine, 45(3), 135-140. https://doi.org/10.1002/lsm.22120

Walther, M., Vestweber, P. K., Kühn, S., Rieger, U. M., Schäfer, J., Münch, C., … and Windbergs, M. (2022). Bioactive insulin-loaded electrospun wound dressings for localized drug delivery and stimulation of protein expression associated with wound healing. Molecular Pharmaceutics, 20(1), 241-254. https://doi.org/10.1021/acs.molpharmaceut.2c00610

Wang, P., Shu, B., Xu, Y., Zhu, J., Liu, J., Zhou, Z., Chen, L., Zhao, J., Liu, X., Qi, S., Xiong, K., Xie, J. (2017). Basic fibroblast growth factor reduces scar by inhibiting the differentiation of epidermal stem cells to myofibroblasts via the notch1/jagged1 pathway. Stem Cell Research & Therapy, 8(1), 1-13. https://doi.org/10.1186/s13287-017-0549-7

Wang, L., Yang, J., Ran, B., Yang, X., Zheng, W., Long, Y., Jiang, X. (2017). Small molecular tgf-β1-inhibitor-loaded electrospun fibrous scaffolds for preventing hypertrophic scars. Acs Applied Materials & Interfaces, 9(38), 32545-32553. https://doi.org/10.1021/acsami.7b09796

Wang, Wei, Yang, C., Wang, X. Y., Zhou, L., Lao, G., Liu, D., Wang, C., Hu, M., Zeng, T., Yan, L., Ren, M. (2018). Microrna-129 and -335 promote diabetic wound healing by inhibiting SP1-mediated MMP-9 expression. Diabetes 67 (8), 1627-1638. https://doi.org/10.2337/db17-1238

Wang, H., Guo, B., Lin, S., Chang, P., Tao, K. (2019). Apigenin inhibits growth and migration of fibroblasts by suppressing fak signaling. Aging, 11(11), 3668-3678. https://doi.org/10.18632/aging.102006

Wang, J., Liao, Y., Xia, J., Wang, Z., Mo, X., Feng, J., Cai, J. (2019). Mechanical micronization of lipoaspirates for the treatment of hypertrophic scars. Stem Cell Research & Therapy, 10(1). https://doi.org/10.1186/s13287-019-1140-1

Wang, Z., Zhao, W., Cao, Y., Liu, Y., Sun, Q., Shi, P., Cai, J., Shen, X., Tan, W. (2020). The roles of inflammation in keloid and hypertrophic scars. Frontiers in Immunology, 11, 1-10. https://doi.org/10.3389/fimmu.2020.603187

Wang, J., Wu, H., Peng, Y., Zhao, Y., Qin, Y., Zhang, Y., Xiao, Z. (2021). Hypoxia adipose stem cell-derived exosomes promote high-quality healing of diabetic wound involves activation of pi3k/akt pathways. Journal of Nanobiotechnology, 19(1), 1-13. https://doi.org/10.1186/s12951-021-00942-0

Wei, Y., Li, J., Huang, Y., Lei, X., Zhang, L., Yin, M., Deng, J., Wang, X., Fu, X., Wu, J. (2022). The clinical effectiveness and safety of using epidermal growth factor, fibroblast growth factor and granulocyte-macrophage colony stimulating factor as therapeutics in acute skin wound healing: a systematic review and meta-analysis. Burns &Amp; Trauma, 10. https://doi.org/10.1093/burnst/tkac002

Wihastyoko, H. and Wuryanjono, W. (2022). The effectiveness of intradermal suture technique on hypertrophic scar prevention in rats. Jurnal Plastik Rekonstruksi, 9(1), 24-29. https://doi.org/10.14228/jprjournal.v9i1.335

Williams, F., Herndon, D., Branski, L. (2014). Where we stand with human hypertrophic and keloid scar models. Experimental Dermatology, 23(11), 811-812. https://doi.org/10.1111/exd.12506

Wong, V., Paterno, J., Sorkin, M., Glotzbach, J., Levi, K., Januszyk, M., Rustad, K. C., Longaker, M. D., Gurtner, G. (2011). Mechanical force prolongs acute inflammationviat-cell-dependent pathways during scar formation. The Faseb Journal, 25(12), 4498-4510. https://doi.org/10.1096/fj.10-178087

Wong, V., Beasley, B., Zepeda, J., Dauskardt, R., Yock, P., Longaker, M., Gurtner, G. (2013). A mechanomodulatory device to minimize incisional scar formation. Advances in Wound Care, 2(4), 185-194. https://doi.org/10.1089/wound.2012.0396

Wu, J., Duca, E., Espino, M., Gontzes, A., Cueto, I., Zhang, N., … and Guttman-Yassky, E. (2020). Rna sequencing keloid transcriptome associates keloids with th2, th1, th17/th22, and jak3-skewing. Frontiers in Immunology, 11, 1-11. https://doi.org/10.3389/fimmu.2020.597741

Xiao, Y., Fan, P., Lei, S., Qi, M., Yang, X. (2015). Mir-138/peroxisome proliferator-activated receptor β signaling regulates human hypertrophic scar fibroblast proliferation and movement in vitro. The Journal of Dermatology, 42(5), 485-495. https://doi.org/10.1111/1346-8138.12792

Xiao, Y., Xu, D., Song, H., Shu, F., Pei, W., Yang, X., … and Xia, Z. (2019). Cuprous oxide nanoparticles reduces hypertrophic scarring by inducing fibroblast apoptosis. International Journal of Nanomedicine, Volume 14, 5989-6000. https://doi.org/10.2147/ijn.s196794

Xu, J., Zhao, W., Fang, Q., Zhang, D., Hu, Y., Zheng, B., Tan, W. (2020). Co-transfection of hepatocyte growth factor and truncated tgf-β type ii receptor inhibit scar formation. Brazilian Journal of Medical and Biological Research, 53(1), 1-6. https://doi.org/10.1590/1414-431x20199144

Yang, R., Qi, S., Shu, B., Ruan, S., Lin, Z., Yang, L., Shen, R., Zhang, F., Chen, X., Xie, J. (2016). Epidermal stem cells (escs) accelerate diabetic wound healing via the notch signalling pathway. Bioscience Reports, 36(4), 1-7. https://doi.org/10.1042/bsr20160034

Yang, Bingxian, Yuxin Zheng, Binjun Yan, Hua-Li Cao, Lilla Landeck, Jiaqi Chen, Wei Li et al., 2020. "Suppressor of fused inhibits skin wound healing", Advances in Wound Care(5), 9:233-244. https://doi.org/10.1089/wound.2018.0890

Yang, D., Li, M., Du, N. (2020). Effects of the circ_101238/mir-138-5p/CDK6 axis on proliferation and apoptosis keloid fibroblasts. Experimental and Therapeutic Medicine, 1995-2002. https://doi.org/10.3892/etm.2020.8917

Yannas, I., Tzeranis, D., So, P. (2017). Regeneration of injured skin and peripheral nerves requires control of wound contraction, not scar formation. Wound Repair and Regeneration, 25(2), 177-191. https://doi.org/10.1111/wrr.12516

Yun, I., Kang, E., Ahn, H., Kim, Y., Rah, D., Roh, T., Yun, C. (2019). Effect of relaxin expression from an alginate gel-encapsulated adenovirus on scar remodeling in a pig model. Yonsei Medical Journal, 60(9), 854. https://doi.org/10.3349/ymj.2019.60.9.854

Yuniati, R., Subchan, P., Riawan, W., Khrisna, M., Restiwijaya, M., Kusumaningrum, N., Nur, M. (2021). Topical ozonated virgin coconut oil improves wound healing and increases HSP90α, VEGF-A, EGF, BFGF and CD34 in diabetic ulcer mouse model of wound healing. F1000research, 9, 580. https://doi.org/10.12688/f1000research.22525.2

Zhang, J., Guan, M., Xie, C., Luo, X., Zhang, Q., Xue, Y. (2014). Increased growth factors play a role in wound healing promoted by noninvasive oxygen-ozone therapy in diabetic patients with foot ulcers. Oxidative Medicine and Cellular Longevity, 2014, 1-8. https://doi.org/10.1155/2014/273475

Zhang, X., Kang, X., Jin, L., Bai, J., Liu, W., and Wang, Z. (2018). Stimulation of wound healing using bioinspired hydrogels with basic fibroblast growth factor (bfgf). International Journal of Nanomedicine, Volume 13, 3897-3906. https://doi.org/10.2147/ijn.s168998

Zhang, Z., Chen, J., Huang, J., Yan, W., Zhang, Y., Chen, X. (2018). Experimental study of 5-fluorouracil encapsulated ethosomes combined with co2 fractional laser to treat hypertrophic scar. Nanoscale Research Letters, 13(1), 1-12. https://doi.org/10.1186/s11671-017-2425-x

Zhang, Y., Liu, Y., Cai, B., Luo, C., Li, D., Wang, S., Luo, S. (2019). Improvement of surgical scars by early intervention with carbon dioxide fractional laser. Lasers in Surgery and Medicine, 52(2), 137-148. https://doi.org/10.1002/lsm.23129

Zhai, X., Tang, Z., Ding, J., Lu, X. (2017). Expression of tgf-β1/mtor signaling pathway in pathological scar fibroblasts. Molecular Medicine Reports, 15(6), 3467-3472. https://doi.org/10.3892/mmr.2017.6437

Zhao, W., Zhang, H., Li, R., Cui, R. (2023). Advances in immunomodulatory mechanisms of mesenchymal stem cells-derived exosome on immune cells in scar formation. International Journal of Nanomedicine, Volume 18, 3643-3662. https://doi.org/10.2147/ijn.s412717

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Research Paper – Araştırma Makalesi

DETERMINATION OF INTERNET USE AMONG PREGNANT WOMEN AND AFFECTING FACTORS: AN ANALYTICAL AND CROSS-SECTIONAL STUDY

GEBE KADINLARDA İNTERNET KULLANIMININ BELİRLENMESİ VE ETKİLEYEN FAKTÖRLER: ANALİTİK VE KESİTSEL BİR ÇALIŞMA

Leman KOCADEMİR[1], Emine Gerçek ÖTER[1]

Özet

Araştırma, gebelerin internet kullanım durumlarını ve etkileyen faktörleri saptamak amacı ile yapılmıştır. Tanımlayıcı ve kesitsel tipteki bu araştırma Ocak-Haziran 2021 tarihleri arasında üniversitesi hastanesi Kadın hastalıkları ve doğum polikliniğine başvuran en az 28 haftalık 403 gebe ile yürütülmüştür. Veriler anket formu kullanılarak toplanmıştır. Verilerin analizi tanımlayıcı istatistikler, ki-kare testi ve post hoc analizi ile gerçekleştirilmiştir. Gebelerin %43,3'ünün interneti sürekli, bilgiye hızlı ve kolay erişim sağlamak için kullandıkları, %78,9'unun interneti her gün kullandığı, %28,3'ünün internette en yaygın olarak aradıkları konunun sağlıklı yaşam tarzı geliştirme olduğu, %65'inin gebelik öncesi döneme göre interneti daha fazla kullandığı, %54,6'sının internette buldukları bilgiye güvendikleri saptanmıştır. Gebelik haftası 33 ve altında, doğum öncesi sağlık bakım hizmeti alan ve planlı gebeliği olan kadınların interneti daha fazla kullandığı ve güvendiği bulunmuştur. ($p<0,05$). Bu çalışma gebelikte internet kullanım durumu ile gebelerin sosyodemografik ve obstetrik özellikleri arasında istatistiksel olarak anlamlı ilişki olduğunu ortaya koymuştur.

Anahtar Kelimeler: Bilgiye Ulaşmak, Bilgi Arama Davranışı, İnternet Kullanımı, Gebelik, Gebe Kadın

Abstract

This research aimed to determine internet use during pregnancy and the affecting factors. This analytical and cross-sectional study was carried out with 403 pregnant women who were at least 28 weeks pregnant and applied to the obstetrics outpatient clinic of a university hospital between January and June 2021. The data was collected through survey and was analyzed using descriptive statistics, chi-square test, and post hoc analysis. It was determined that 43.3% of pregnant women used the internet due to the continuous, fast, and easy access; 78.9% of them searched for information on the internet every day. The most often searched topics on the internet were developing a healthy lifestyle (28.3%) and fetal development, (24.0%) respectively. The rate of those who used the internet more during pregnancy compared to the pre-pregnancy period was 65.0%, and 54.6% of women usually trusted the information they found on the internet. Pregnant women aged 28 or younger, graduted university and above, having an income exceeding their expenses, being employed, being primigravida, being in the gestational week of 33 or less, receiving prenatal health care services, and planning their pregnancy used the internet more ($p<0.05$) and trusted the information they accessed on the internet ($p<0.05$). This study is important since it revealed that internet use by pregnant women increased compared to the pre-pregnancy period and that sociodemographic and obstetric variables were effective in internet use among pregnant women.

Keywords: Access To Information, Information Seeking Behavior, Internet Use, Pregnancy, Pregnant Women

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1. INTRODUCTION

Pregnancy is a period that gives women the opportunity to learn, plan, and prepare for motherhood and requires compliance with physiological, psychological, and social changes in their lives (Herman et al., 2014, pp. 450-461; Zhu et al., 2019, pp. 1-12). In this process, pregnant women constantly search for information about the changes in their physical and mental states, find solutions to health problems, and prepare for delivery (Dinç et al., 2014, pp. 68-76; Evcili, 2019, pp. 409-414). For this purpose, they obtain information from health professionals, newspapers, magazines, books, libraries, television, and the internet, or from relatives, neighbors, and friends. In recent years, due to the ease of access with the spread of technology, the internet has become a first-choice source of health information for pregnant women (Kamali et al., 2017, pp. pp. 24-37; Baker and Yang, 2018, pp. 31-34; Zhu et al., 2019, pp. 1-12; Ghiasi, 2021, pp. 1320-1330).

Pregnant women may not get sufficient information from health institutions due to factors such as the embarrassment of talking about pregnancy issues, inability to reach health professionals or waiting for a long time in front of the clinic, negative attitudes of health professionals, lack of time, language barriers, and economic problems (Das Sarkar, 2014, pp. 251–262; Chan and Chen, 2019, pp. 11836; Ghiasi, 2021, pp. 1320-1330). Therefore, they use the internet, which can be easily accessible to meet their information needs, more (Bert et al., 2013, pp. 1013-1018; Huberty et al., 2013, pp. 1363–1372; Bjelke et al., 2016, pp. 187–191; Wallwiener et al., 2016, pp. 937–944; Ford ve Alwan, 2018, pp. 5294–5303; Jacobs et al., 2019, pp. 9-14). In a previous study, it has been found that pregnant women used the internet since it is easy to access information instantly, information is regularly transferred, detailed information is provided, pregnancy experiences are presented entertainingly, information is customized according to the person, it is practical and easy to interact with professional people, and it is reassuring and objective (Lupton, 2016, pp. 171).

Today, the internet is considered the most popular and easiest way to get information on health-related topics (Gao et al., 2013, pp. 730–735; Kraschnewski et al., 2014; Sayakhot and Carolan-Olah, 2016, pp. 61; Dai et al., 2022, pp. 1281-1289). Through internet access, pregnant women can easily access pregnancy-related information anytime and anywhere (Tripp et al., 2014, pp. 64–67; Robinson and Jones, 2014, pp. 23–25). It has been stated that pregnant women do not know how to evaluate the accuracy of information during pregnancy, do not check the source of information, misuse the internet, and receive information from unreliable and misleading internet sources (Lagan et al., 2010, pp. 106–115; Öztürk et al., 2020, pp. 210-220). Therefore, women's information needs during pregnancy, sources of information, frequency of reaching information, and reliability of information have become issues that should be addressed by health professionals working in the field of women's health. Today, when technological developments accelerate, mobile health applications are rapidly used in the field of obstetrics. For this reason, it is essential to determine women's use of internet-based digital technologies during pregnancy. This study aimed to determine pregnant women's internet use and the factors affecting it, and how the internet affects women's pregnancy processes.

2. METHODS

2.1. Study design, setting and participants

This analytical and cross-sectional study was conducted in the gynecology and obstetrics clinic of a university hospital in a city located in western Turkey. Pregnant women with different socioeconomic statuses apply to this hospital. The annual number of pregnant women who apply to the obstetrics outpatient clinic was 12,894. The sample size was calculated using the formula ($n=N^2.p.q/S^2(N-1)+t^2q$) which is used when the number of individuals in the population is known. The sample size was determined as 370 based on the research conducted by Kavlak et al. (2012), considering the rate of internet use among pregnant women as 45% ($p = 0.45$) with a probability of 95% ($\alpha = 0.05$), a deviation of $d = 0.05$, $q = 0.55$, and $t = 1.96$. (G Power) Considering potential losses, approximately 10% of the sample size was added and the study was completed with 403 pregnant women (Sümbüloğlu and Sümbüloğlu, 2005). The random sampling method, one of the improbable sampling methods, was used for sample selection in the research. The inclusion criteria for pregnant women were being aged over 18, being in the gestational week of at least 28 weeks (neden olduğunu belirt), being literate, being able to use the internet, and being able to read and understand Turkish. Pregnant women with communication disabilities such as visual and hearing impairment were excluded from the research.

2.2. Variables of the Study

The dependent variables of the research were the reasons for using the internet to access information, the need for information, the time spent on the internet to get information, the status of accessing information, the rate of using the internet compared to the pre-pregnancy period, the status of trusting the information accessed on the internet, the status of verifying the information obtained from health professionals using the internet, and the effect of the internet on the decision regarding the mode of delivery. The independent variables were sociodemographic characteristics (age, education status, employment status, income status) and obstetric characteristic (number of pregnancies, gestational week, prenatal health care, having a planned pregnancy).

2.3. Data Collection Tools and Measurements

The data were collected using a survey which was prepared by the researchers according to the literature (Larsson, 2009, pp. 14–20; Lagan et al., 2010, pp. 106–115; Lagan et al., 2011, pp. 336–345; Bert et al., 2013, pp. 1013-1018; Gao et al., 2013, pp. 730–735; Bjelke et al., 2016, pp. 187–191; Lupton, 2016, pp. 171; Sayakhot and Carolan-Olah, 2016, pp. 61; Kamali et al., 2017, pp. 24-37; Baker and Yang, 2018, pp. 31-34; Jacobs et al., 2019, pp. 9-14). The form consists of three sections, sociodemographic (age, education, employment and income status) and obstetric characteristics (number of pregnancies, gestational week, prenatal health care, having a planned pregnancy), and internet use during pregnancy (information needs, making a decision, verifying information, providing support, etc.), and a total of 47 open/closed questions.

The study data were collected from pregnant women who were at least 28 weeks pregnant old and applied to the obstetrics outpatient clinic of a university hospital for follow-

up or control examination between January and June 2021. The survey was filled in with pregnant women using the face-to-face interview technique. Before the interview, pregnant women were informed about the scope of the study, that the research aimed to determine internet use among pregnant women, that their answers to the questions would be kept confidential, and that their identity or names would not be written on the form. The data were collected in an empty or suitable room in the clinic in order to carry out the interviews in a healthy manner and ensure the privacy of the pregnant women. It took 20 minutes to complete the survey.

2.4. Data analysis

Statistical analyses of the data were performed with the licensed SPSS 26.0 (forMacOS) package program. Descriptive statistics were presented as mean (± standard deviation, SD) or median (25-75% or minimum, maximum), frequency, and percentage. The intergroup comparison of the categorical data was performed using the chi-square test and post hoc analysis. Type-1 error was taken as 0.05%.

2.5. Ethical consideration

Ethical approval was taken from the Noninvasive Clinical Research Ethics Committee of the Nursing Faculty of Aydın Adnan Menderes University (number: 2020/207, date: 10/9/2020). To carry out the research, institutional permission was taken from the university hospital. The pregnant women participating in the study were informed about the research and their written consent was taken. No pressure was exerted on pregnant women regarding participation in the study and voluntary participation was ensured.

3. RESULTS

The sociodemographic and obstetric characteristics of the pregnant women are given in Table-1. The mean age of the pregnant women was 28.3 ± 5.8 (min – max = 18 - 41). Of the pregnant women, 96.5% were married; 64.8% were high school and below; 63.3% were unemployed; 64.5% had an income equal to or less than their expenses; 86.1% were multigravida; 51.1% had a gestational week of 33 weeks or less. The mean gestational week was 33.3 ± 3.3 (min-max=28-41). Of the pregnant women, 65.0% did not receive prenatal health care support and 68.7% had a planned pregnancy.

Table 1: Distribution characteristics of pregnant

Sociodemographic characteristics	**Mean±SD**	**Min-Max**
Age	28.3 ± 5.8	18.0-41.0
≤ 28	221	54.9
>28	182	45.1
Education level		
High school and below	261	64.8
University and above	142	35.2
Employment status		
Employed	148	36.7

Unemployed	255	63.3
Income status		
Income > Expenses	143	35.5
Income ≤ Expenses	260	64.5
Gestational week	33.3 ± 3.3	28.0-41.0
Number of pregnancies		
Primigravida	56	13.9
Multigravida	347	86.1
Gestational week		
≤ 33	206	51.1
>33	197	48.9
Status of receiving prenatal health care		
Yes	141	35.0
No	262	65.0
Status of having a planned pregnancy		
Yes	277	68.7
No	126	31.3

Pregnant women included in the study sought information on the internet mostly due to 24/7, fast, and easy access (43.3%). They looked for information on the internet mostly during the first trimester of pregnancy. (38.5%). Of the pregnant women, 47.6% used the internet for two hours or more a day; 52.9% usually found the information they searched on the internet; 28.3% searched most commonly for developing a healthy lifestyle and 24.0% searched for fetal development on the internet; 65.0% used the internet more since pregnancy; 54.6% reported that they generally confidential the information they sought on the internet; 64.5% did not confirm the information they received from the health professional on the internet; 73.9% tended to vaginal delivery more with internet use. (Table 2)

Table 2: Distribution of pregnant women according to internet use during pregnancy

	n	**%**
***Reasons for using the internet to access information**		
Finding information anonymously	305	38.8
24/7, fast and easy access to the internet	340	43.3
Possibility to interact with health professionals on the internet	98	12.5
Neutral and safe	43	5.5
***Need for information-seeking**		
In the first trimester	185	38.5
In the second trimester	49	10.2
In the third trimester	133	27.7
Throughout pregnancy	113	23.5
Time spent on the internet to get information		
Less than one hour/day	113	28.0
One hour/day	98	24.3
Two hours or more/day	192	47.6
Status of accessing the information about pregnancy sought on the internet		
Always	71	17.6
Usually	213	52.9
Sometimes / Never	119	29.5
Rate of using the internet during pregnancy compared to the pre-pregnancy period		
More	262	65.0
Less	14	3.5

No change	127	31.5
Status of trusting information accessed on the internet		
Always	56	13.9
Usually	220	54.6
Never/Partially	127	31.5
Verifying information received from a health professional on the internet		
Yes	143	35.5
No	260	64.5
Effect of the internet on the decision about the mode of delivery		
Vaginal	298	73.9
Cesarean	105	26.1

* More than one option is marked.

In Table 3, there is a statistically significant difference between the need for information-seeking according to the pregnancy period, the time spent on the internet to get information, the status of accessing the information on the internet, the rate of using the internet compared to the pre-pregnancy period, and the effect of the internet on the decision about the mode of delivery and the age variable ($p<0.05$). A statistically significant difference was found between the pregnant women with high school degree or lower degrees and those who had an associate degree, bachelor's degree, or postgraduate degree in terms of the time spent on the internet to get information, the status of accessing the information on the internet, the effect of accessing the information on the internet on pregnancy, the rate of using the internet compared to the pre-pregnancy period, and the status of trusting the information accessed on the internet ($p<0.05$). There was a statistically significant difference between employed and unemployed women in terms of the need for information-seeking according to the pregnancy period, the time spent on the internet to get information, the effect of accessing the information on the internet on pregnancy, the rate of using the internet compared to the pre-pregnancy period, the status of trusting the information accessed on the internet, and the effect of the internet on the decision about the mode of delivery ($p<0.05$). A statistically significant difference was found between the pregnant women who had an income more than their expenses and those who had an income equal to or less than their expenses in terms of the reason for using the internet to get information, the time spent on the internet in a day, the status of accessing the information on the internet, the contribution of the internet compared to other types of social support, and the status of trusting the information accessed on the internet ($p<0.05$).

Table 3: Comparison of internet use during pregnancy according to sociodemographic characteristics

	Age				**χ^2 p**	**Education level**				**χ^2 p**	**Employment status**				**χ^2 p**	**Income level**				**χ^2 p**
	≤28		**>28**			**High school and below**		**University and above**			**Employed**		**Unemployed**			**Income > Expenses**		**Income ≤ Expenses**		
	n	**%**	**n**	**%**		**n**	**%**	**n**	**%**		**n**	**%**	**n**	**%**		**n**	**%**	**n**	**%**	
****Reasons for using the internet to access information**																				
Finding information anonymously	136	37.6	169	39.9	5.949	191	40.4	114	36.4	3.447	120	36.9	185	40.1	2.307	122	41.5[a]	183	37.2[a]	28.467
24/7, fast and easy access to the internet	170	47.0	170	40.1		205	43.3	135	43.1		141	43.4	199	43.2		122	41.5[a]	218	44.3[a]	
Possibility to interact with health professionals on the internet	42	11.6	56	13.2	0.114	56	11.8	42	13.4	0.328	42	12.9	56	12.1	0.511	21	7.1[a]	77	15.7[b]	**0.000***
Neutral and safe	14	3.9	29	6.8		21	4.4	22	7.0		22	6.8	21	4.6		29	9.9[a]	14	2.8[b]	
****Need for information-seeking**																				
In the first trimester[(AR=3.1)]	108	45.4[a]	77	31.8[b]	20.956	107	38.9	78	38.0	6.175	78	48.1[a]	107	33.6[b]	31.688	58	33.9	127	41.1	2.967
In the second trimester[(AR=2.3)]	32	13.4	17	7.0[b]		21	7.6	28	13.7		0	.0[a]	49	15.4		21	12.3	28	9.1	

		[a]								0.103				[b]						0.397
In the third trimester[(AR=3.5)]	49	20.6[a]	84	34.7[b]	**0.000**	84	30.5	49	23.9		42	25.9[a]	91	28.6[a]	**0.000**	49	28.7	84	27.2	
Throughout pregnancy	49	20.6[a]	64	26.4[a]		63	22.9	50	24.4		42	25.9[a]	71	22.3[a]		43	25.1	70	22.7	
Time spent on the internet to get information																				
Less than one hour/day[(AR=3.2)]	72	35.1[a]	41	20.7[b]	19.171	106	40.6[a]	7	4.9[b]	65.653	21	14.2[a]	92	36.1[b]	54.098	28	19.6[a]	85	32.7[b]	29.341
One hour/day[(AR=3.9)]	33	16.1[a]	65	32.8[b]	**0.000**	63	24.1[a]	35	24.6[a]	**0.000**	21	14.2[a]	77	30.2[b]	**0.000**	21	14.7[a]	77	29.6[b]	**0.000***
Two hours or more/day	100	48.8[a]	92	46.5[a]		92	35.2[a]	100	70.4[b]		106	71.6[a]	86	33.7[b]		94	65.7[a]	98	37.7[b]	
Status of accessing the information about pregnancy sought on the internet																				
Always[(AR=3.7)]	22	10.7[a]	49	24.7[b]	18.269	43	16.5[a]	28	19.7[a]	42.081	28	18.9	43	16.9	3.891	21	14.7[a]	50	19.2[a]	30.871
Usually	108	52.7[a]	105	53.0[a]	**0.000***	113	43.3[a]	100	70.4[b]	**0.000***	85	57.4	128	50.2		101	70.6[a]	112	43.1[b]	**0.000***
Sometimes/Never[(AR=3.2)]	75	36.6[a]	44	22.2[b]		105	40.2[a]	14	9.9[b]		35	23.6	84	32.9	0.143	21	14.7[a]	98	37.7[b]	

Table 3: Comparison of internet use during pregnancy according to sociodemographic characteristics (continue)

Rate of using the internet during pregnancy compared to the pre-pregnancy period																				
More	135	65.9[a]	127	64.1[a]	11.743	156	59.8[a]	106	74.6[b]	13.389	28	18.9[a]	28	11.0[b]	10.27	93	65.0	169	65.0	1.435
Less[(AR=3.2)]	13	6.3[a]	1	0.5[b]	**0.003**	14	5.4[a]	0	.0[b]		92	62.2[a]	128	50.2[b]	**0.05**	7	4.9	7	2.7	
No change	57	27.8[a]	70	35.4[a]		91	34.9[a]	36	25.4[b]	**0.001**	28	18.9[a]	99	38.8[b]		43	30.1	84	32.3	0.488
Status of trusting information accessed on the internet																				
Always	26	12.7	30	15.2	4.325	42	16.1[a]	14	9.9[a]	23.896	28	18.9[a]	28	11.0[b]	20.027	28	19.6[a]	28	10.8[b]	31.000
Usually	115	56.1	105	53.0	0.228	120	46.0[a]	100	70.4[b]	**0.000**	92	62.2[a]	128	50.2[b]	**0.000**	94	65.7[a]	126	48.5[b]	**0.000***
Never/Partly	64	31.2	63	31.8		99	37.9[a]	28	19.7[b]		28	18.9[a]	99	38.8[b]		21	14.7[a]	106	39.8[b]	
Verifying information received from a health professional on the internet																				
Yes	77	37.6	66	33.3	0.786 0.405	85	32.6	58	40.8	2.753	57	38.5	86	33.7	0.938 0.333	58	40.6	85	32.7	2.494
No	128	62.4	132	66.7		176	67.4	84	59.2	0.097	91	61.5	169	66.3		85	59.4	175	67.3	0.114
Effect of the internet on the decision about the mode of delivery																				
Vaginal	178	86.8	120	60.6	35.949 **0.000**	198	75.9	100	70.4	1.412	99	66.9	199	78.0	6.040	101	70.6	197	75.8	1.265
Cesarean	27	13.2	78	39.4		63	24.1	42	29.6	0.235	49	33.1	56	22.0	0.014	42	29.4	63	24.2	0.261

* For each row, there is no difference between the columns with the same letters and there is a difference between the columns with different letters and the significance arises from the difference in that row. AR value shows the level of statistical significance (AR=Adjusted residual)
** More than one option is marked.

In Table 4, there was a statistically significant difference between primigravida and multigravida pregnant women in terms of the need for information-seeking according to trimesters, the time spent on the internet to get information, the rate of using the internet during pregnancy compared to the pre-pregnancy period, the contribution of the internet compared to other types of social support, the status of trusting the information accessed on the internet, and the effect of the internet on the decision about the mode of delivery ($p<0.05$). A statistically significant difference was found between pregnant women with a gestational week of 33 and below and those with a gestational week of 33 and above in terms of the need for information-seeking according to trimesters, the time spent on the internet to get information, the status of accessing information, the rate of using the internet during pregnancy compared to the pre-pregnancy period, the status of trusting the information accessed on the internet, and the effect of the internet on the decision about the mode of delivery ($p<0.05$). There was a statistically significant difference between pregnant women who received prenatal health care services and those who did not receive in terms of the need for information-seeking according to trimesters,

the time spent on the internet to get information, the status of accessing information, the rate of using the internet during pregnancy compared to the pre-pregnancy period, the status of trusting the information accessed on the internet, the status of verifying information received from a health professional on the internet, and the effect of the internet on the decision about the mode of delivery ($p<0.05$). A statistically significant difference was found between pregnant women who had planned pregnancy and those who had an unplanned pregnancy in terms of the reason for using the internet to get information, the time spent on the internet to get information, and the status of trusting the information accessed on the internet ($p<0.05$).

Table 4: Comparison of internet use during pregnancy according to obstetric characteristics

	Number of pregnancies				χ^2 p	Gestational week				χ^2 p	Status of receiving prenatal health care				χ^2 p	Status of having a planned pregnancy				χ^2 p
	Primigravida		Multigravida			≤33 weeks		>33 weeks			Yes		No			Yes		No		
	n	%	n	%		n	%	n	%		n	%	n	%		n	%	n	%	
****Reasons for using the internet to access information**																				
Finding information anonymously	42	40.0	263	38.6	3.959	171	38.7	134	39.0	6.557	120	38.7	185	38.9	6.049	214	41.2[a]	91	34.2[a]	19.263
24/7, fast and easy access to the internet	49	46.7	291	42.7		179	40.5	161	46.8		127	41.0	213	44.7		235	45.2[a]	105	39.5[a]	
Possibility to interact with health professionals on the internet	7	6.7	91	13.4	0.266	63	14.3	35	10.2	0.087	49	15.8	49	10.3	0.109	49	9.4[a]	49	18.4[b]	**0.000***
Neutral and safe	7	6.7	36	5.3		29	6.6	14	4.1		14	4.5	29	6.1		22	4.2[a]	21	7.9[b]	
****Need for information-seeking**																				
In the first trimester[(AR=2.1)]	35	50.0[a]	150	36.6[b]	34.932	108	46.8[a]	77	30.9[b]	54.571	92	52.3[a]	93	30.6[b]	22.691	129	38.7	56	38.1	3.548
In the second trimester	7	10.0[a]	42	10.2[a]		15	6.5[a]	34	13.7[b]		14	8.0[a]	35	11.5[a]		35	10.5	14	9.5	
In the third trimester[(AR=5.6)]	0	.0[a]	133	32.4[b]	**0.000***	34	14.7[a]	99	39.8[b]	**0.000***	35	19.9[a]	98	32.2[b]	**0.000***	98	29.4	35	23.8	0.315
Throughout pregnancy[(AR=3.5)]	28	40.0[a]	85	20.7[b]		74	32.0[a]	39	15.7[b]		35	19.9[a]	78	25.7[a]		71	21.3	42	28.6	
Time spent on the internet to get information																				
Less than one hour/day[(AR=5.0)]	0	.0[a]	113	32.6[b]	43.658	26	12.6[a]	87	44.2[b]	56.881	14	9.9[a]	99	37.8[b]	37.762	85	30.7[a]	28	22.2[a]	21.166
One hour/day[(AR=2.2)]	7	12.5[a]	91	26.2[b]		50	24.3[a]	48	24.4[a]		49	34.8[a]	49	18.7[b]		49	17.7[a]	49	38.9[b]	
Two hours or more/day[(AR=6.4)]	49	87.5[a]	143	41.2[b]	**0.000***	130	63.1[a]	62	31.5[b]	**0.000***	78	55.3[a]	114	43.5[b]	**0.000***	143	51.6[a]	49	38.9[b]	**0.000***
Status of accessing the information about pregnancy sought on the internet																				
Always	7	12.5	64	18.4	2.564	37	18.0[a]	34	17.3[a]	9.694	14	9.9[a]	57	21.8[b]	26.511	43	15.5	28	22.2	2.679
Usually	35	62.5	178	51.3		122	59.2[a]	91	46.2[b]	**0.008**	99	70.2[a]	114	43.5[b]		150	54.2	63	50.0	0.262
Sometimes/Never	14	25.0	105	30.3	0.278	47	22.8[a]	72	36.5[b]		28	19.9[a]	91	34.7[b]	**0.000***	84	30.3	35	27.8	

Table 4: Comparison of internet use during pregnancy according to obstetric characteristics (continue)

Variables	Number of pregnancies				χ^2 p	Gestational week				χ^2 p	Status of receiving prenatal health care				χ^2 p	Status of having a planned pregnancy				χ^2 p
	Primigravida		Multigravida			≤33 weeks		>33 weeks			Yes		No			Yes		No		
	n	%	n	%		n	%	n	%		n	%	n	%		n	%	n	%	
Rate of using the internet during pregnancy compared to the pre-pregnancy period																				
	49	87.5[a]	213	61.4[b]	14.779	136	66.0[a]	126	64.0[a]	15.519	99	70.2[a]	163	62.2[a]	8.642	185	66.8	77	61.1	2.908
Less	0	.0[a]	14	4.0[a]	**0.0001***	0	.0[a]	14	7.1[b]	**0.000***	0	.0[a]	14	5.3[b]	**0.013***	7	2.5	7	5.6	0.234
No change[(AR=3.3)]	7	12.5[a]	120	34.6[b]		70	34.0[a]	57	28.9[a]		42	29.8[a]	85	32.4[a]		85	30.7	42	33.3	
Contribution of the internet compared to other types of social support (such as family, relatives, and friends)																				
Better	56	100.0	304	87.6	7.76 **0.005**	186	90.3	174	88.3	0.409 0.523	134	95	226	86.3	7.407 **0.006**	248	89.5	112	88.9	0.037 0.847

Worse	0	.0	43	12.4		20	9.7	23	11.7		7	5	36	13.7		29	10.5	14	11.1	
Status of trusting information accessed on the internet																				
Always[(AR=2.6)]	14	25.0[a]	42	12.1[b]	31.229	35	17.0[a]	21	10.7[a]	54.723	21	14.9[a]	35	13.4[a]	15.601	42	15.2[a]	14	11.1[a]	17.898
Usually[(AR=3.3)]	42	75.0[a]	178	51.3[b]	**0.000**	140	68.0[a]	80	40.6[b]	**0.000***	92	65.2[a]	128	48.9[b]	**0.001***	157	56.7[a]	63	50.0[a]	**0.000***
Never/Partially[(AR=5.5)]	0	.0[a]	127	36.6[b]		31	15.0[a]	96	48.8[b]		28	19.9[a]	99	37.8[b]		78	28.2[a]	49	38.9[b]	
Verifying information received from a health professional on the internet																				
Yes	14	25.0	129	37.2	3.123 0.077	73	35.4	70	35.5	0.000 0.984	35	24.8	108	41.2	10.768 **0.001***	101	36.5	42	33.3	0.370 0.543
No	42	75.0	218	62.8		133	64.6	127	64.5		106	75.2	154	58.8		176	63.5	84	66.7	
Effect of the internet on the decision about the mode of delivery																				
Vaginal	49	87.5	249	71.8	6.202 **0.013**	140	68.0	158	80.2	7.833 0.005*	92	65.2	206	78.6	8.515 **0.004***	114	80.3	184	70.5	4.569 0.033
Cesarean	7	12.5	98	28.2		66	32.0	39	19.8		49	34.8	56	21.4		28	19.7	77	29.5	

4. DISCUSSION

In the research conducted to determine internet use among pregnant women, it was determined that pregnant women used the internet mostly (%43.3) due to 24/7, fast, and easy access to get information. In studies in the literature, which have reported similar findings to our research findings, it has been reported that pregnant women used the internet to get extra information in addition to the information given by health professionals (52-92.8%), quickly and easily access information (68.4-83.8%), receive help in making decisions about pregnancy (62-75.5%), share experience (67.8%), and obtain social support (43.7%) (Lagan et al., 2010, pp. 106–115; Kamali et al., 2017, pp. 24-37; Jacobs et al., 2019, pp. 9-14; Wexler et al., 2020). It was determined that the pregnant women participating in the study needed to seek information mostly during the first trimester of pregnancy. Likewise, it has been reported in studies that pregnant women sought information on the internet more in the first trimester of pregnancy (Bert et al., 2013, pp. 1013-1018; Gao et al., 2013, pp. 730–735; Jacobs et al., 2019, pp. 9-14). The first trimester refers to the process in which women adapt to the new condition and are affected by many psychological and physiological factors, it is expected that they will use the internet more (Arslan et al., 2019).

In our study, it was found that the most common topics that pregnant women searched for on the internet were developing a healthy lifestyle and fetal development. In other studies in the literature, the most commonly searched topics have been reported as fetal development (23.8-87.6%), physiological changes during pregnancy (71%), physical activity during pregnancy (3.4-33.9%), nutrition (14,6-78.5%), pregnancy complications (32.3-61.6%), pregnancy follow-ups and test results (7.6-37.4%), drug use during pregnancy (49.3%), sexuality during pregnancy (21.5%), labor (39.3-53.2%), mode of delivery (47.2%), birth stages (23.8-92.8%), postpartum period and newborn care (6.2-43.%6) (Huberty et al., 2013, pp. 1363–1372; Bjelke et al., 2016, pp. 187–191; Lupton, 2016, pp. 171; Narasimhulu et al., 2016; Anasi and Allison, 2018; Baker and Yang, 2018, pp. 31-34; Jacobs et al., 2019, pp. 9-14; Zhu et al., 2019, pp. 1-12; Wexler et al., 2020; Koyun and Erbektaş, 2018; Batman, 2018;).

In our study, it was found that 94.8% of pregnant women were not orientated to reliable internet resources by health workers. In other studies with similar findings, it has been stated that pregnant women who had problems accessing reliable information on the internet wanted to be orientated by health professionals to websites including reliable pregnancy-related information, desired health professionals to provide more information during prenatal follow-ups and to receive online support for potential problems (Jacobs et al., 2019, pp. 9-14; Batman,

2018; Camacho-Morell, Esparcia, 2020). In their study, Chan and Chen (2019) stated that it is of great importance for health professionals to examine the media literacy skills of pregnant women who are seeking health information on the internet and evaluate effective internet use and emphasized the importance of all kinds of educational interventions that will improve the skills regarding finding, reading, understanding, interpreting, evaluating, and sharing pregnancy-related information.

Pregnant women in the age group of 28 and below were found to need more information in the first and second trimesters compared to pregnant women aged over 28 whereas the need for information-seeking was found to be higher in the third trimester among the pregnant women aged 28 and over. Studies have reported that young pregnant women spend more time on the internet (Fleming, Vandermause and Shaw, 2014; Lee and Moon, 2016; Lee and Moon, 2016; Hadımlı, Demirelöz Akyüz and Tuna Oran, 2018). It was seen that pregnant women with a high school degree or lower levels spent less than one hour on the internet whereas pregnant women with a university and above levels spent two hours or more on the internet. It was determined that pregnant women with an university and above or high school and below used the internet more during pregnancy compared to those with a high school and below levels. In studies supporting our research findings, it has been stated that there was a correlation between education level and internet use (Kavlak et al., 2012; Sayakhot and Carolan-Olah, 2016, pp. 61; Öztürk Güneş et al., 2020, pp. 210-220; Bayrak and Kanbur, 2022).

It was established that employed pregnant women spent more time on the internet than pregnant women who were unemployed, that they positively evaluated the effect of the internet on pregnancy, that they used the internet more compared to the pre-pregnancy period, and that they interpreted the contribution of the internet as better than other types of social support. Likewise, in the study conducted by Kavlak et al. (2012), it was detected that working pregnant women spent more time on the internet than non-working women. It is expected that working pregnant women do not have enough time to reach healthcare centers and health professionals, know how to investigate for information on the internet, try to meet the lack of information from the internet, and as a result spend more time on the internet with easy access. It was found that pregnant women who had an income more than their expenses spent more time on the internet, usually accessed the information they searched for on the internet, and positively interpreted the effect of the internet on pregnancy compared to the pregnant women who had an income equal to or less than their expenses. In the study administered by Sis Çelik and Aksoy Derya (2019), it was reported that internet use among pregnant women with a high income level was more common.

It was determined that primigravidas needed more information in the first trimester of pregnancy compared to multigravidas and that multigravidas needed more information in the third trimester of pregnancy. It was found that primigravidas spent more time on the internet than multigravidas, positively interpreted the effect of the internet on pregnancy, used the internet more compared to the pre-pregnancy period, interpreted the contribution of the internet as better compared to other types of social support, confidential in the information they accessed on the internet more, and tended to vaginal delivery. In some studies supporting our study, it has been defined that the number of pregnancies affects the time spent on the internet and that nulliparous women spend more time on the internet than multiparous women (Kavlak et al., 2012; Fleming, Vandermause and Shaw, 2014; Jacobs et al., 2019, pp. 9-14; Bayrak and Kanbur, 2022).

In the research conducted by Kamali et al. (2017), it was reported that the number of pregnancies is effective in internet use. The fact that primigravida pregnant women face this

new process for the first time in their lives may prompt them to seek information constantly. It was observed that pregnant women with a gestational week of 33 and less trusted the information they accessed on the internet more, positively evaluated the effect of the internet on pregnancy, and confidential the information they accessed on the internet more. Studies have demonstrated that women most frequently search for information on the internet in the early weeks of pregnancy (Bert et al., 2013, pp. 1013-1018; Gao et al., 2013, pp. 730–735; Jacobs et al., 2019, pp. 9-14; Öztürk Güneş et al., 2020, pp. 210-220). It was determined that pregnant women who received prenatal health care services spent more time on the internet, usually trusted the information they accessed on the internet, used the internet more compared to the pre-pregnancy period, interpreted the contribution of the internet as better compared to other types of social support, and trusted the information they accessed on the internet more. It was seen that pregnant women who had a planned pregnancy spent more time on the internet than those who had an unplanned pregnancy and that they partially or never trusted the information they accessed on the internet. It was also seen that pregnant women who had an unplanned pregnancy used the internet mostly to communicate with health professionals. Studies have reported that pregnant women who desired a planned pregnancy used the internet more frequently (Öztürk Güneş et al., 2020, pp. 210-220; Bayrak and Kanbur, 2022).

Limitations

The study has some limitations:

Since the pregnant women included in the research were determined using the random sampling method, the results of the study comprise only the women included in the sample. Due to the cross-sectional design of the study, the data obtained may change over time. Since the survey used for data collection was applied using the face-to-face meeting technique, the reliability of the data is limited to the accuracy of the information indicated by the pregnant women and cannot be generalized to all pregnant women.

Conflict of interest

There is no conflict of interest between the authors.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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There is no disagreement of interest between the authors.

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5. REFERENCES

Anasi, S. N. I., and Allison, G. O. (2018). Sociodemographic determinants of information sources availability and use among pregnant women in Ilisan-Remo, Ogun state, Nigeria. Journal of Hospital Librarianship, 18(1), 47–63. DOI:10.1080/15323269.2018.1400833

Arslan, S., Okçu, G., Coşkun, A. M., Temiz F. (2019). Kadınların gebeliği algılama durumu ve bunu etkileyen faktörler. Sağlık Bilimleri ve Meslekleri Dergisi, 6(1), 179-192. https://doi.org/10.17681/hsp.432333

Baker, B., Yang, I. (2018). Social media as social support in pregnancy and the postpartum. Sexual and Reproductive Healthcare, 17, 31-34. https://doi.org/10.1016/j.srhc.2018.05.003

Batman, D. (2018). Gebe kadınların gebelikleriyle ilgili araştırdığı konular ve bilgi kaynakları: Nitel bir çalışma. Kocaeli Üniversitesi Sağlık Bilimleri Dergisi, 4(3): 63-69. https://doi.org/10.30934/kusbed.427777

Bayrak, E., Kanbur, A. (2022). Gebelerde internet yoluyla karar alma ile sağlık uygulamaları arasındaki ilişkinin incelenmesi. İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksek Okulu Dergisi, 10 (1), 255-269. https://doi.org/10.33715/inonusaglik.1010546

Bert, F., Gualano, M. R., Brusaferro, S., De Vito, E., De Waure, C., La Torre, G., Siliquini, R. (2013). Pregnancy e-health: A multicenter Italian cross-sectional study on Internet use and decision-making among pregnant women. Journal of Epidemiology and Community Health, 67(12), 1013–1018. DOI: 10.1136/jech-2013-202584

Bjelke, M., Martinsson, A. K., Lendahls, L., Oscarsson, M. (2016). Using the internet as a source of information during pregnancy – a descriptive cross-sectional study in Sweden. Midwifery, 40, 187–191. https://doi.org/10.1016/j.midw.2016.06.020

Camacho-Morell, F., Esparcia, J. (2020). Influence and use of information sources about childbearing among Spanish pregnant women. Women and Birth: Journal of the Australian College of Midwives, 33(4), 367–376. https://doi.org/10.1016/j.wombi.2019.08.003

Chan, K. L., Chen, M. (2019). Effects of social media and mobile health apps on pregnancy care: Meta-analysis. JMIR mHealth and uHealth, 7(1), e11836. DOI: 10.2196/11836

Dai, J., Yu, Y., Wang, Y., Huang, Y., Liu, J., Lin, Y., Fan, X., Zhang, M., Xu, X., Bai, J., Chen, H., Liu, Y. (2022). The Experience of Pregnant Women in the Health Management Model of Internet-Based Centering Pregnancy: A Qualitative Study. Int J Womens Health, 7;14:1281-1289. doi: 10.2147/IJWH.S375675

Das, A., Sarkar, M. (2014). Pregnancy-related health information-seeking behaviors among rural pregnant women in India: Validating the Wilson model in the Indian context. The Yale Journal of Biology and Medicine, 87(3), 251–262. PMID: 25191141

Dinç, H., Yılmaz, T., Günaydın, S., Yazıcı, S. (2014). Gebe eğitimi. HSP, 1(1), 68-76.

Evcili, F. (2019). A study on the relationship between internet use, anxiety levels, and quality of life of Turkish pregnant women. Perspectives in psychiatric care, 55(3), 409–414. DOI:

10.1111/ppc.12326

Fleming, S. E., Vandermause, R., Shaw, M. (2014). First-time mothers preparing for birthing in an electronic world: Internet and mobile phone technology. J Reprod Infant Psychol. 32(3):240–253. DOI:10.1080/02646838.2014.886104

Ford, A. J., Alwan, N. A. (2018). Use of social networking sites and women's decision to receive vaccinations during pregnancy: A cross-sectional study in the UK. Vaccine, 36(35), 5294–5303. DOI: 10.1016/j.vaccine.2018.07.022

Gao, L. L., Larsson, M., Luo, S. Y. (2013). Internet use by Chinese women seeking pregnancy-related information. Midwifery, 29(7), 730–735. DOI: 10.1016/j.midw.2012.07.003

Ghiasi, A. (2021). Health information needs, sources of information, and barriers to accessing health information among pregnant women: A systematic review of research. The Journal of Maternal-Fetal and Neonatal Medicine, 34(8), 1320-1330. DOI: 10.1080/14767058.2019.1634685

Hadımlı, A., Demirelöz, Akyüz, M., Tuna, Oran, N. (2018). Gebelerin interneti kullanma sıklıkları ve nedenleri. Life Sciences (NWSALS), 13(3):32-43. DOI:10.12739/NWSA.2018.13.3.4B0018

Herman, D. R., Taylor, B. M., Adams, E. (2014). Life course perspective: Evidence for the role of nutrition. Matern Child Health J, 18:450-461. DOI: 10.1007/s10995-013-1280-3. DOI: 10.1007/s10995-013-1280-3

Huberty, J., Dinkel, D., Beets, M. W., Coleman, J. (2013). Describing the use of the internet for health, physical activity, and nutrition information in pregnant women. Maternal and Child Health Journal, 17(8), 1363–1372. DOI: 10.1007/s10995-012-1160-2

Jacobs, E., Van, Steijn, M. E., Van Pampus, M. G. (2019). Internet usage of women attempting pregnancy and pregnant women in the Netherlands. Sexual Reproductive Healthcare: Official Journal of the Swedish Association of Midwives, 21, 9–14. DOI: 10.1016/j.srhc.2019.04.005

Kamali, S., Ahmadian, L., Khajouei, R., Bahaadinbeigy, K. (2017). Health information needs of pregnant women : İnformation sources, motives and barriers. Heal Inf Libr J, 35(1):24–37. DOI: 10.1111/hir.12200

Kavlak, O., Atan, S. Ü., Güleç, D., Öztürk, R., Atay, N. (2012). Pregnant women's use of the internet in relation to their pregnancy in Izmir, Turkey. Informatics for Health Social Care, 37(4), 253–263. DOI: 10.3109/17538157.2012.710686

Koyun, A., Erbektaş, G. (2018). Gebelikte İnternet Yoluyla Karar Alma Ölçeği"nin geliştirilmesi, Uluslararası Hakemli Kadın Hastalıkları ve Anne Çocuk Sağlığı Dergisi Ocak / Şubat / Mart / Nisan Kış İlkbahar Dönemi, Sayı: 12. Doi: 10.17367/JACSD.2018.1.6

Kraschnewski, J. L., Chuang, C. H., Poole, E. S., Peyton, T., Blubaugh, I., Pauli, J., Feher, A., Reddy, M. (2014). Paging Dr. Google: Does technology fill the gap created by the prenatal care visit structure qualitative focus group study with pregnant women. Journal of Medical Internet Research, 16(6), [e147]. doi: 10.2196/jmir.3385

Lagan, B. M., Sinclair, M., Kernohan, W. G. (2010). Internet use in pregnancy informs women's decision making: A web-based survey. Birth (Berkeley, Calif.), 37(2), 106–115. DOI: 10.1111/j.1523-536X.2010.00390.x

Lagan, B. M., Sinclair, M., Kernohan, W. G. (2011). What is the impact of the Internet on decision-making in pregnancy? A global study. Birth (Berkeley, Calif.), 38(4), 336–345. DOI: 10.1111/j.1523-536X.2011.00488.x

Larsson, M. (2009). A descriptive study of the use of the Internet by women seeking pregnancy-related information. Midwifery, 25(1), 14–20. DOI: 10.1016/j.midw.2007.01.010

Lee, Y., Moon, M. (2016). Utilization and content evaluation of mobile applications for pregnancy, birth, and child care. Healthcare İnformatics Research, 22(2), 73–80. doi: 10.4258/hir.2016.22.2.73

Lupton, D. (2016). The use and value of digital media for information about pregnancy and early motherhood: A focus group study. BMC Pregnancy Childbirth, 16, 171. DOI: 10.1186/s12884-016-0971-3

Narasimhulu, D. M., Karakash, S., Weedon, J., Minkoff, H. (2016). Patterns of internet use by pregnant women, and reliability of pregnancy-related searches. Maternal and Child Health Journal, 20(12), 2502–2509. DOI: 10.1007/s10995-016-2075-0

Öztürk, Güneş, G., Ünlü, N., Uzunkaya, N. E., Karaçam, Z. (2020). Gebelerin Bilgi Kaynağı Olarak İnternet ve Sosyal Medya Kullanım Durumları, Adnan Menderes Üniversitesi Sağlık Bilimleri Fakültesi Dergisi, 4(3); 210-220. https://doi.org/10.46237/amusbfd.667048

Robinson, F., Jones, C. (2014). Women's engagement with mobile device applications in pregnancy and childbirth. The Practising Midwife, 17(1), 23–25. PMID: 24520591

Sayakhot, P., Carolan-Olah, M. (2016). Internet use by pregnant women seeking pregnancy-related information: A systematic review. BMC Pregnancy and Childbirth, 16, 65.

Sis, Çelik, A., Aksoy, D. Y. (2019). Gebelerin öz bakım gücü ile sağlık uygulamaları düzeylerinin ve etkileyen faktörlerin belirlenmesi. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi, 8(1), 111-119.

Sümbüloğlu, V., Sümbüloğlu, K. (2005). Klinik ve saha araştırmalarında örnekleme yöntemleri ve örneklem büyüklüğü, 1. Baskı, Ankara, Hatiboğlu Yayınevi.

Tripp, N., Hainey, K., Liu, A., Poulton, A., Peek, M., Kim, J., Nanan, R. (2014). An emerging model of maternity care: smartphone, midwife, doctor?. Women and Birth: Journal of the Australian College of Midwives, 27(1), 64–67. DOI: 10.1016/j.wombi.2013.11.001

Wallwiener, S., Müller, M., Doster, A., Laserer, W., Reck, C., Pauluschke-Fröhlich, J., Brucker, S. Y., Wallwiener, C. W., Wallwiener, M. (2016). Pregnancy eHealth and mHealth: User proportions and characteristics of pregnant women using Web-based information sources-a cross-sectional study. Archives of Gynecology and Obstetrics, 294(5), 937–944. DOI: 10.1007/s00404-016-4093-y

Wexler, A., Davoudi, A., Weissenbacher, D., Choi, R., O' Connor, K., Cummings H., Gonzalez-Hernandez, G. (2020). Pregnancy and health in the age of the internet: A content analysis of online "birth club" forums. PloS one, 15(4), e0230947. doi: 10.1371/journal.pone.0230947

Zhu, C., Zeng, R., Zhang, W., Evans, R., He, R. (2019). Pregnancy-related information seeking and sharing in the social media era among expectant mothers: Qualitative study. Journal of medical Internet research, 21(12). DOI: 10.2196/13694

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Research Paper – Araştırma Makalesi

THE RELATIONSHIP OF UNIMANUAL AND BIMANUAL CAPACITY WITH PERCEIVED BIMANUAL PERFORMANCE IN CHILDREN WITH UNILATERAL CEREBRAL PALSY

UNİLATERAL SEREBRAL PALSİLİ ÇOCUKLARDA UNİMANUEL VE BİMANUEL KAPASİTENİN ALGILANAN BİMANUEL PERFORMANSLA İLİŞKİSİ

Hilal Başak CAN[1,2], Gönül ACAR[2], Gaye TORNA[3], Çiğdem ÇEKMECE[4], Fuat BİLGİLİ[3]

Özet

Çalışmada 6-12 yaş aralığındaki unilateral Serebral Palsi'li çocuklarda unimanuel ve bimanuel kapasitenin algılanan bimanuel performansla ilişkisini araştırmak amaçlandı. Çalışmaya yaş ortalaması 9,47±1,62 yıl olan, 15'i kız ve 19'u erkek olmak üzere toplam 34 çocuk katıldı. Her iki elin unimanuel kapasitesini ölçmek için Minnesota El Becerisi Testi'nin (MEBT) yerleştirme alt testi ve Kutu ve Blok Testi (KBT) kullanıldı. Bimanuel kapasite MEBT'in döndürme alt testi ile değerlendirildi. Ebeveynler, Çocukların El Kullanım Deneyimi Anketi (ÇEDA) ve ABILHAND-Kids aracılığıyla algılanan bimanüel performansı değerlendirdi. KBT ve yerleştirme testi ile ölçülen etkilenen elin kapasitesinin ÇEDA alt skalaları ile düşük-orta düzeyde ve ABILHAND-Kids ile düşük düzeyde anlamlı ilişkili olduğu ($p<0,05$); bimanuel kapasitenin ÇEDA alt skalaları ile düşük-orta ve ABILHAND-Kids ile düşük düzeyde anlamlı ilişkili olduğu bulundu ($p<0,05$). Kontralateral elin MEBT'nin yerleştirme alt testi ile ölçülen kapasitesinin ÇEDA'nın hissedilen rahatsızlık alt skalası ile düşük düzeyde anlamlı ilişkisi olduğu saptandı ($p<0,05$). Sonuçlar, etkilenen elin kapasitesi ve bimanuel kapasitenin algılanan bimanuel performansla ilişkili olduğunu ortaya koydu. Ancak, bu kapasiteler tarafından algılanan bimanuel performansın tahmin edilebilirliği düşüktü.

Anahtar Kelimeler: Bimanuel Kapasite, Bimanuel Performans, Unimanuel Kapasite, Unilateral Serebral Palsi

Abstract

The aim of this investigation was to examine the correlation between unimanual and bimanual capacities as well as the perceived bimanual performance among children diagnosed with unilateral cerebral palsy, aged between 6 and 12 years. A total of 34 children, consisting of 15 girls and 19 boys with a mean age of 9.47±1.62 years, participated. The placing test, which is one of the subtests of the Minnesota Manual Dexterity Test (MMDT), and the Box and Block Test (BBT) were used to quantify the unimanual capacity of both hands. Bimanual capacity was evaluated with the turning test, another subtest of the MMDT. Parents evaluated perceived bimanual performance through the Children's Hand-Use Experience Questionnaire (CHEQ) and ABILHAND-Kids. The capacity of the affected hand, quantified by the BBT and placing test, was found to be significantly correlated with the CHEQ subscales at a low to moderate level and with ABILHAND-Kids at a low level ($p<0.05$). Bimanual capacity demonstrated a significant correlation ranging from low to moderate with the CHEQ subscales, and exhibited a weak correlation with ABILHAND-Kids ($p<0.05$). It was observed that the capacity of the contralateral hand, as measured by the MMDT placing test, exhibited a low level of significant correlation with the CHEQ subscale feeling bothered ($p<0.05$). The results revealed that the capacity of the affected hand and bimanual capacity were related to perceived bimanual performance. However, the predictability of perceived bimanual performance by these capacities was low.

Keywords: Bimanual capacity, bimanual performance, unimanual capacity, unilateral cerebral palsy

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1. INTRODUCTION

Functional limitations of the affected arm and hand in children with unilateral cerebral palsy (CP) may inhibit them from participating in activities of daily living (Klingels et al., 2010, pp. 887-900). The severity of these limitations is in relation to brain damage features and the reorganization process of the corticospinal tract (Gordon, Bleyenheuft and Steenbergen, 2013, pp. 32-37). One of the main focuses regarding the rehabilitation of these children is the functional use of the affected upper limb in daily life. Therefore, both unimanual capacity, that is, "what the affected hand can do" when it is asked to use it, and bimanual performance, that is, "how it is used" in activities necessitating the use of both hands together, hold significant importance (Sakzewski, Ziviani and Boyd, 2010, pp. 811-816). Among the most effective treatments for improving hand function are stand constraint-induced movement therapy, which is a unimanual approach, and bimanual therapy; these two therapies have been deemed complementary to each other in those with unilateral CP. After developing unimanual actions with constraint-induced movement therapy, it has been proposed to use bimanual therapy to transform these acquired skills into bimanual performance (Hoare and Greaves, 2017, pp. 47-59). However, it has been reported that the order in which these two therapies are received does not make clinically meaningful differences (Au et al., 2023, pp. 490).

Poor bimanual performance in many daily activities is the major functional problem for children diagnosed with unilateral CP (Greaves, Imms, Dodd and Krumlinde-Sundholm, 2010, pp. 413-421). The affected hand has lower unimanual capacity, and the capacity of the contralateral hand in addition to the affected hand is below normative values (Tomhave, Van Heest, Bagley and James, 2015, pp. 900-907). Bimanual performance in early childhood improves with increasing age (Klevberg et al., 2018, pp. 490-497). Although unimanual capacity improves over time, deterioration in bimanual performance was noted after the age of 9, which may be related to sensory deficits and developmental disregard (Klingels et al., 2018, p. 2831342).

Sensibility and muscle strength, especially distal muscle strength, are determinants of affected hand capacity and bimanual performance (Klingels et al., 2012, pp. 475-484). While a robust association between the capacity of the affected hand and observed bimanual performance has been highlighted in the existing literature (Chaleat-Valayer et al., 2015, pp. 193-201), no such study has been found regarding perceived bimanual performance. Furthermore, it remains unclear whether bimanual capacity is related to bimanual performance. Hence, the aim of the present study was to investigate the relationship between unimanual/bimanual capacities and the perceived bimanual performance of children diagnosed with unilateral CP, aged between 6 and 12 years.

2. METHODS

Approval for this study, which had a cross-sectional design and was conducted in compliance with the Declaration of Helsinki criteria, was granted by the Marmara University Faculty of Health Sciences Human Ethics Committee (25.04.2024/75). Informed consent was obtained from children verbally and from parents in writing.

2.1. Participants

Children diagnosed with unilateral CP between 6 and 12 years who had 1, 2, and 3 of the Manual Ability Classification System (MACS) and 4 and above scores of the House Functional Classification System (HFCS) were included in the study. In addition, the children were required to be capable of comprehending and completing the test procedures, and to have no uncorrected hearing or vision problems, or attention deficit. Children who had undergone any orthopaedic surgery and/or performed injections of botulinum toxin A in the upper-limbs in previous six months were excluded from the study. In a power analysis conducted using G*Power 3.1.9.7, the sample size required to achieve 80% power was calculated to be at least 29 (effect size: 0.5, $\alpha = 0.05$) (Faul, Erdfelder, Lang and Buchner, 2007, pp. 175-191).

2.2. Instruments

The Box and Block Test (BBT) assesses how many 2.5-cm cubes individuals can transfer as fast as possible between compartments of the box in one minute. A greater number of cubes indicates better unimanual capacity (Liang, Chen, Shieh and Wang, 2021, p. 20955; Mathiowetz, Federman and Wiemer, 1985, pp. 241-245). The Minnesota Manual Dexterity Test (MMDT) employs 60 discs, painted one side red and the other black, and a foldable board with 4 rows of 15 holes in each row, for a total of 60 holes. The test comprises two subtests. It is desirable to complete both tests as quickly as possible in accordance with predetermined patterns. In the placing test, children are instructed to place the discs in the holes by evaluated hand. In the turning test, it is required to place the discs in the holes by taking them with one hand and turning them while passing them to the other hand (Wang, Wickstrom, Yen, Kapellusch and Grogan, 2018, pp. 339-347). The unimanual capacity of the affected and contralateral hand was evaluated using the BBT and MMDT placing test, while the bimanual capacity was evaluated using the MMDT turning test.

The Children's Hand-Use Experience Questionnaire (CHEQ) is a tool that can be used to assess the experience of children with unilateral CP in utilizing their affected hand during various bimanual tasks (Amer, Eliasson, Peny-Dahlstrand and Hermansson, 2016, pp. 743-749; Sköld, Hermansson, Krumlinde-Sundholm and Eliasson, 2011, pp. 436-442). This allows evaluating the utilization of the affected hand in bimanual tasks, comparing the time required to complete these tasks with that of peers, and assessing feelings of discomfort experienced during the tasks (Amer et al., 2016, pp. 743-749; Eren, Ekici and Alkan, 2022, pp. 34-45; Sköld et al., 2011, pp. 436-442). The instrument is available at no cost via https://www.cheq.se, and the results of the Rasch analysis can be accessed from the report obtained from the website. ABILHAND-Kids is a questionnaire that evaluates the perceived ease and difficulty of performing 21 activities, the majority of which are bimanual, in children with CP (Arnould, Penta, Renders and Thonnard, 2004, pp. 1045-1052). The website https://www.rehab-scales.org/scale/abilhand-kids provides access to the questionnaire and allows for the retrieval of Rasch analysis results. The parents were asked to complete the Turkish versions of CHEQ and ABILHAND-Kids, which are found valid and reliable (Eren et al., 2022, pp. 34-45; Şahin et al., 2020, pp. 444-451).

2.3. Statistical analyses

The SPSS 11.5 program was employed to analyse the data, and the significance level was accepted as 0.05. Depending on the Shapiro-Wilk test, it was determined whether there was a relationship between capacity and performance with either Pearson's correlation test or Spearman's rank order correlation test. Among the correlation coefficients obtained as a result of the study, those ranging from 0.3 to 0.5 were interpreted as low, and those ranging from 0.5

to 0.7 were interpreted as moderate (Mukaka, 2012, pp. 69-71). Bimanual performance variables were considered dependent variables, and simple linear regression was performed for those variables exhibiting a significant relationship.

3. RESULTS

The study was conducted on 34 children, aged minimum 6 and maximum 12 years (mean age 9.47±1.62 years). 55.9% of the children were male, 67.6% were right-sided, 55.9% were level I according to MACS, and half scored 5 on the HFCS (Table-1). The children's unimanual and bimanual capacities, along with their bimanual performances, were as presented in Table-2.

Table 1: Demographics and functional levels of participants

Characteristic	Frequency	
	N	%
Gender		
Male	19	55.9
Female	15	44.1
Affected side		
Right	23	67.6
Left	11	32.4
MACS		
1	19	55.9
2	8	23.5
3	7	20.6
HFCS		
5	17	50
6	6	17.6
7	6	17.6
8	5	14.7

MACS: Manual Ability Classification System; HFCS: House Functional Classification System; n: number of participants.

Table 2: Results of BBT, MMDT, CHEQ, and ABILHAND-Kids

Assessment	Mean±SD (min-max)
BBT	
Contralateral side	45.82 ± 8.75 (23-62)
Affected side	31.5 ± 11.87 (10-54)
MMDT	
Placing test	
Contralateral side	101.76 ± 22.21 (80-192)
Affected side	187.41 ± 83.16 (84-387)
Turning test	185.35 ± 93.84 (76-486)
CHEQ	
Grasp efficacy	48.74 ± 17.18 (9-83)
Time consumption	53.53 ± 14.49 (29-82)
Feeling bothered	54.91 ± 15.92 (30-91)
ABILHAND-Kids	2.37 ± 1.24 (0.17-4.35)

BBT: Box and Block Test; MMDT: Minnesota Manual Dexterity Test; CHEQ: Children's Hand-Use Experience Questionnaire; SD: Standard Deviation; min: Minimum; max: Maximum.

Analyses revealed that only the MMDT placing test result of the contralateral hand had a low-level negative correlation with CHEQ feeling bothered (r: -0.407, p: 0.017), which is one of the indicators of bimanual performance. A moderate-level positive correlation was observed between the affected hand's capacity, assessed by BBT, and the CHEQ grasp efficacy (r: 0.529, p: 0.001), while a low-level positive correlation was found with other CHEQ subscales (r: 0.407, p: 0.017 for time consumption; r: 0.393, p: 0.022 for feeling bothered) and ABILHAND-Kids (r: 0.362, p: 0.035). The affected hand's capacity, as evaluated by the MMDT placing test, exhibited a negative moderate correlation with all subscales of the CHEQ (r: -0.627, p: <0.001 for grasp efficacy; r: -0.565, p: <0.001 for time consumption; r: -0.512, p: 0.002 for feeling bothered) and a negative low correlation with ABILHAND-Kids (r: -0.443, p: 0.009). A negative moderate level relationship was determined between bimanual capacity and CHEQ grasp efficacy (r: -0.578, p: <0.001) and time consumption (r: -0.515, p: 0.002) subscales, and a negative low-level relationship with CHEQ feeling bothered (r: -0.492, p: 0.003) and ABILHAND-Kids (r: -0.373, p: 0.030) (Table-3).

Table 3: The Correlation Findings of Unimanual and Bimanual Capacity with Bimanual Performance

		BBT		MMDT		
				Placing test		
		Contralateral side	Affected side	Contralateral side	Affected side	Turning test
CHEQ	Grasp efficacy	r: 0.016 p: 0.930 [a]	r: 0.529 p: 0.001 [a*]	r: -0.203 p: 0.250 [b]	r: -0.627 p: <0.001 [b*]	r: -0.578 p: <0.001 [b*]
	Time consumption	r: -0.027 p: 0.880 [a]	r: 0.407 p: 0.017 [a*]	r: -0.339 p: 0.050 [b]	r: -0.565 p: <0.001 [b*]	r: -0.515 p: 0.002 [b*]
	Feeling bothered	r: -0.031 p: 0.864 [a]	r: 0.393 p: 0.022 [a*]	r: -0.407 p: 0.017 [b*]	r: -0.512 p: 0.002 [b*]	r: -0.492 p: 0.003 [b*]
ABILHAND-Kids		r: -0.026 p: 0.884 [b]	r: 0.362 p: 0.035 [b*]	r: -0.297 p: 0.088 [b]	r: -0.443 p: 0.009 [b*]	r: -0.373 p: 0.030 [b*]

BBT: Box and Block Test (unimanual capacity); MMDT: Minnesota Manual Dexterity Test (unimanual and bimanual capacity); CHEQ: Children's Hand-Use Experience Questionnaire (bimanual performance); r: Correlation coefficient; a: Pearson's correlation test; b: Spearman's rank order correlation test.

Regression analysis demonstrated that the affected hand's capacity accounted for 28-35% of the grasp efficacy of the affected hand, 17-21% of the time consumption, and 15-20% of the feeling bothered. It was determined that it explained 16-17% of the perceived bimanual performance evaluated with ABILHAND-Kids. The results indicated that bimanual capacity explained 33%, 15%, 17%, and 13% of the variance in CHEQ grasp efficacy, CHEQ time consumption, CHEQ feeling bothered, and ABILHAND-Kids, respectively (Table-4).

Table 4: Predictive Level of Unimanual and Bimanual Capacity on Bimanual Performance

Dependent variable	Independent variable	R	R^2	F	B	SE	Beta	t	P
CHEQ-Grasp efficacy	BBT-affected side	0.529	0.280	12,461	0.766	0.217	0.529	3.530	0.001
	MMDT-Placing test-Affected side	0.592	0.351	17.283	-0.122	0.029	-0.592	-4.157	<0.001
	MMDT-Turning test	0.578	0.334	16.072	-0.106	0.026	-0.578	-4.009	<0.001
CHEQ- Time consumption	BBT-affected side	0.407	0.166	6.351	0.497	0.197	0.407	2.520	0.017

	MMDT-Placing test-Affected side	0.459	0.210	8.528	-0.080	0.027	-0.459	-2.920	0.006
	MMDT-Turning test	0.393	0.154	5.833	-0.061	0.025	-0.393	-2.415	0.022
CHEQ-Feeling bothered	BBT-affected side	0.393	0.154	5.834	0.527	0.218	0.393	2.415	0.022
	MMDT-Placing test-Contralateral side	0.167	0.028	0.923	-0.120	0.125	-0.167	-0.961	0.344
	MMDT-Placing test-Affected side	0.446	0.199	7.926	-0.085	0.030	-0.446	-2.815	0.008
	MMDT-Turning test	0.416	0.173	6.706	-0.071	0.027	-0.416	-2.590	0.014
ABILHAND-Kids	BBT-affected side	0.398	0.158	6.018	0.042	0.017	0.398	2.453	0.020
	MMDT-Placing test-Affected side	0.411	0.169	6.508	-0.006	0.002	-0.411	-2.551	0.016
	MMDT-Turning test	0.365	0.133	4.911	-0.005	0.002	-0.365	-2.216	0.034

BBT: Box and Block Test (unimanual capacity); MMDT: Minnesota Manual Dexterity Test (unimanual and bimanual capacity); CHEQ: Children's Hand-Use Experience Questionnaire (bimanual performance); R: Correlation Coefficient; R^2: R-Squared; F: F-Statistic; B: Unstandardized Coefficient; SE: Standard Error; Beta: Standardized Coefficient; t: t-Statistic. Simple linear regression.

4. DISCUSSION

This study investigated whether the perceived bimanual performance of the children aged 6–12 with unilateral CP was related to their unimanual capacity of the affected and contralateral hand and bimanual capacity. The primary result of this study is affected hand's capacity and bimanual capacity were revealed to be related to bimanual performance. Secondly, the results indicated that the capacity of the contralateral hand was only related to feeling bothered during bimanual performance.

It was observed that as the capacity of the affected hand and bimanual capacity increased, the utilization of the affected hand in bimanual tasks increased, also the time to complete bimanual tasks was comparable with peers. Moreover, feelings of being bothered during bimanual tasks and perceived difficulty in most bimanual tasks decreased. The strength of these correlations was low to moderate. Chaleat-Valayer et al. demonstrated a high correlation between the capacity of the affected hand as well as bimanual performance in children with hemiplegic CP and that the capacity explains 70% of the performance (Chaleat-Valayer et al., 2015, pp. 193-201). Similarly, in children with congenital hemiplegia, there has been evidence of a robust correlation, and furthermore, 75% of the variability in bimanual performance was accounted for by unimanual capacity together with stereognosis collectively (Sakzewski et al., 2010, pp. 811-816). It is worth noting that this current study differs from the two previously published studies in terms of the methodology employed. In contrast to this study, the previously published studies used the Melbourne Test (MUUL) to assess unimanual capacity and the Assisting Hand Assessment (AHA) to evaluate bimanual performance (Chaleat-Valayer et al., 2015, pp. 193-201; Sakzewski et al., 2010, pp. 811-816). AHA, which

was used in the mentioned studies, and CHEQ, which we used as an outcome measure for bimanual performance, are instruments that assess different yet interrelated aspects of bimanual performance. While CHEQ evaluates the perceived performance, AHA measures the observed performance. The CHEQ subscales account for only a small proportion, between 8 and 25%, of the observed variance in the AHA (Ryll, Bastiaenen and Eliasson, 2017, pp. 199-209).

Another difference from previous studies was the instruments used to evaluate unimanual capacity. MUUL is focused on unilateral upper-limb movement quality (Randall, Carlin, Chondros and Reddihough, 2001, pp. 761-767), while BBT and MMDT are concerned with speed and dexterity (Mathiowetz et al., 1985, pp. 241-245; Wang et al., 2018, pp. 339-347). The discrepancy between the relationship levels detected in the present study and those previously researches may be attributed to the differing tools employed for assessment. Future studies should aim to reveal whether this discrepancy is related to the evaluation instruments. In general terms, the present study corroborates the findings of previous studies, which have demonstrated that there was a relationship unimanual capacity and bimanual performance. The research to date has not considered the impact of bimanual capacity on bimanual performance. Another potential area for future investigation may be the results of the current study related to these two.

The distinction between capacity, the function of the hand in a standard environment at the highest level, and performance, the perceived or observed function of the hand in daily life, is an essential one. It should be noted that the capacity to use the hand for a task does not necessarily imply that that person actually uses their hand for the relevant task in real life (Krumlinde-Sundholm and Wagner, 2020, pp. 1569-1597; Lemmens, Timmermans, Janssen-Potten, Smeets and Seelen, 2012, p. 21). The moderate correlation between the affected hand's capacity and performance in bimanual tasks, along with the fact that it can only account for 28–35% of performance in bimanual tasks, indicates that the affected hand's capacity only reflects its perceived use in daily life to a limited extent. Conversely, the observation that the capacity of the contralateral hand is only weakly related to the experience of bothering during bimanual tasks and is insufficient to account for the observed change in feeling bothered suggests that the capacity of the affected hand may have played a more decisive role in the perception of bimanual performance.

The regression analyses indicate that the capacity of the affected hand accounts for 15–35% of the CHEQ subscales and 16–17% of the ABILHAND-Kids; bimanual capacity explains 15–33% of the CHEQ subscales and 13% of the ABILHAND-Kids. The results indicated that the perceived using of the affected hand during bimanual tasks had low predictability based on its capacity and bimanual capacity. This suggests the existence of other potential factors that can significantly explain the change in perceived bimanual performance. Klingels et al. demonstrated that 46% of ABILHAND-Kids was explained by wrist strength and stereognosis from body structure measurements (Klingels et al., 2012, pp. 475-484). Furthermore, when the predictability of the bimanual performance of the affected hand capacities evaluated by BBT and MMDT was examined, it was observed that MMDT was better. Whereas in BBT, the cubes are taken from one compartment of the box and left in any order in the other compartment of the box, regardless of the order, in MMDT, the discs must be placed in the holes of the folding board in a specific order. This implies that MMDT demands greater hand-eye coordination and precision. The evidence that MMDT is superior at elucidating variance suggests that hand-eye coordination and sensitivity may be additional contributing factors that can explain perceived performance.

The study's limited sample size of 34 children precludes the ability to generalize the observed results. However, the findings from the current study can inform future studies utilizing larger samples.

5. CONCLUSION

The study found that the perceived bimanual performance of the children aged 6–12 with unilateral CP was weakly to moderately related to their affected hand's capacity and bimanual capacity. The predictability of perceived bimanual performance by these capacities was low. The aim of upper-limb interventions in these children is to enhance bimanual performance. The study's findings suggest that improvements in perceived bimanual performance can be achieved through therapeutic interventions that will increase unimanual and bimanual capacity.

6. REFERENCES

Amer, A., Eliasson, A. C., Peny-Dahlstrand, M., Hermansson, L. (2016). Validity and test-retest reliability of Children's Hand-use Experience Questionnaire in children with unilateral cerebral palsy. *Dev Med Child Neurol, 58*(7), 743-749. doi:10.1111/dmcn.12991

Arnould, C., Penta, M., Renders, A., Thonnard, J. L. (2004). ABILHAND-Kids: a measure of manual ability in children with cerebral palsy. *Neurology, 63*(6), 1045-1052. doi:10.1212/01.wnl.0000138423.77640.37

Au, K. L. K., Knitter, J. L., Morrow-McGinty, S., Campos, T. C., Carmel, J. B., Friel, K. M. (2023). Combining Unimanual and Bimanual Therapies for Children with Hemiparesis: Is There an Optimal Delivery Schedule? *Behav Sci (Basel), 13*(6), 490. doi:10.3390/bs13060490

Chaleat-Valayer, E., Bard-Pondarre, R., Ganne, C., Roumenoff, F., Combey, A., Bernard, J. C. (2015). Relation between unimanual capacities and bimanual performance in hemiplegic cerebral-palsied children: impact of synkinesis. *Eur J Paediatr Neurol, 19*(2), 193-201. doi:10.1016/j.ejpn.2014.12.002

Eren, M., Ekici, G., Alkan, H. (2022). Reliability and validity of turkish version of children's hand use experience questionnaire for children with hemiparetic cerebral palsy. *International Journal of Health Administration and Education Congress (Sanitas Magisterium), 8*(1), 34-45. Retrieved from https://dergipark.org.tr/tr/pub/ijhadec/issue/65894/1027949

Faul F, Erdfelder E, Lang A-G, Buchner A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175-191. doi: 10.3758/bf03193146.

Gordon, A. M., Bleyenheuft, Y., Steenbergen, B. (2013). Pathophysiology of impaired hand function in children with unilateral cerebral palsy. *Dev Med Child Neurol, 55 Suppl 4*, 32-37. doi:10.1111/dmcn.12304

Greaves, S., Imms, C., Dodd, K., Krumlinde-Sundholm, L. (2010). Assessing bimanual performance in young children with hemiplegic cerebral palsy: a systematic review. *Dev Med Child Neurol, 52*(5), 413-421. doi:10.1111/j.1469-8749.2009.03561.x

Hoare, B., Greaves, S. (2017). Unimanual versus bimanual therapy in children with unilateral cerebral palsy: Same, same, but different. *J Pediatr Rehabil Med, 10*(1), 47-59. doi:10.3233/prm-170410

Klevberg, G. L., Elvrum, A. G., Zucknick, M., Elkjaer, S., Østensjø, S., Krumlinde-Sundholm, L., Kjeken, I., Jahnsen, R. (2018). Development of bimanual performance in young children with cerebral palsy. *Dev Med Child Neurol, 60*(5), 490-497. doi:10.1111/dmcn.13680

Klingels, K., Demeyere, I., Jaspers, E., De Cock, P., Molenaers, G., Boyd, R., Feys, H. (2012). Upper limb impairments and their impact on activity measures in children with unilateral cerebral palsy. *Eur J Paediatr Neurol, 16*(5), 475-484. doi:10.1016/j.ejpn.2011.12.008

Klingels, K., Jaspers, E., Van de Winckel, A., De Cock, P., Molenaers, G., Feys, H. (2010). A systematic review of arm activity measures for children with hemiplegic cerebral palsy. *Clin Rehabil, 24*(10), 887-900. doi:10.1177/0269215510367994

Klingels, K., Meyer, S., Mailleux, L., Simon-Martinez, C., Hoskens, J., Monbaliu, E., Verheyden, G., Verbeke, G., Molenaers, G., Ortibus, E., Feys, H. (2018). Time Course of Upper Limb Function in Children with Unilateral Cerebral Palsy: A Five-Year Follow-Up Study. *Neural Plast, 2018*, 2831342. doi:10.1155/2018/2831342

Krumlinde-Sundholm, L., Wagner, L. V. (2020). Upper Extremity Assessment and Outcome Evaluation in Cerebral Palsy. In F. Miller, S. Bachrach, N. Lennon, M. E. O'Neil (Eds.), *Cerebral Palsy* (pp. 1569-1597). Cham: Springer International Publishing.

Lemmens, R. J., Timmermans, A. A., Janssen-Potten, Y. J., Smeets, R. J., Seelen, H. A. (2012). Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review. *BMC Neurol, 12*, 21. doi:10.1186/1471-2377-12-21

Liang, K. J., Chen, H. L., Shieh, J. Y., Wang, T. N. (2021). Measurement properties of the box and block test in children with unilateral cerebral palsy. *Sci Rep, 11*(1), 20955. doi:10.1038/s41598-021-00379-3

Mathiowetz, V., Federman, S., Wiemer, D. (1985). Box and Block Test of Manual Dexterity: Norms for 6–19 Year Olds. *Canadian Journal of Occupational Therapy, 52*(5), 241-245. doi:10.1177/000841748505200505

Mukaka, M. M. (2012). Statistics corner: A guide to appropriate use of correlation coefficient in medical research. *Malawi Med J, 24*(3), 69-71.

Randall, M., Carlin, J. B., Chondros, P., Reddihough, D. (2001). Reliability of the Melbourne assessment of unilateral upper limb function. *Dev Med Child Neurol, 43*(11), 761-767. doi:10.1017/s0012162201001396

Ryll, U. C., Bastiaenen, C. H., Eliasson, A. C. (2017). Assisting Hand Assessment and Children's Hand-Use Experience Questionnaire -Observed Versus Perceived Bimanual Performance in Children with Unilateral Cerebral Palsy. *Phys Occup Ther Pediatr, 37*(2), 199-209. doi:10.1080/01942638.2016.1185498

Sakzewski, L., Ziviani, J., Boyd, R. (2010). The relationship between unimanual capacity and bimanual performance in children with congenital hemiplegia. *Dev Med Child Neurol, 52*(9), 811-816. doi:10.1111/j.1469-8749.2009.03588.x

Sköld, A., Hermansson, L. N., Krumlinde-Sundholm, L., Eliasson, A. C. (2011). Development and evidence of validity for the Children's Hand-use Experience Questionnaire (CHEQ). *Dev Med Child Neurol, 53*(5), 436-442. doi:10.1111/j.1469-8749.2010.03896.x

Şahin, E., Dilek, B., Karakaş, A., Engin, O., Gülbahar, S., Faruk Dadaş, Ö., Peker, M. Ö., El, Ö. (2020). Reliability and Validity of the Turkish Version of the ABILHAND-Kids Survey in Children with Cerebral Palsy. *Turk J Phys Med Rehabil, 66*(4), 444-451. doi:10.5606/tftrd.2020.4091

Tomhave, W. A., Van Heest, A. E., Bagley, A., James, M. A. (2015). Affected and contralateral hand strength and dexterity measures in children with hemiplegic cerebral palsy. *J Hand Surg Am, 40*(5), 900-907. doi:10.1016/j.jhsa.2014.12.039

Wang, Y. C., Wickstrom, R., Yen, S. C., Kapellusch, J., Grogan, K. A. (2018). Assessing manual dexterity: Comparing the WorkAbility Rate of Manipulation Test with the Minnesota Manual Dexterity Test. *J Hand Ther, 31*(3), 339-347. doi:10.1016/j.jht.2017.03.009

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Araştırma Makalesi – Research Paper

TELERADYOLOJİ ALANINDAKİ BİLİMSEL YAYINLARIN BİBLİYOMETRİK VE İÇERİK ANALİZİ İLE İNCELENMESİ

EXAMINATION OF SCIENTIFIC PUBLICATIONS IN THE FIELD OF TELERADIOLOGY WITH BIBLIOMETRIC AND CONTENT ANALYSIS

İbrahim TÜRKMEN[1], Serpil EMİKÖNEL[2], Engin TEKİN[2]

Özet

Teleradyoloji, tele-tıbbın bir parçası olarak, görüntülerin alındığı yer ile bu görüntüleri değerlendiren radyoloğun farklı bir konumda olması durumunda bile tanısal incelemelerin yapılabilmesini ifade etmektedir. Teleradyoloji, radyoloji uygulamalarının ayrılmaz bir parçası haline gelmiş ve uzaktan görüntüleme ile değerlendirme işlemlerinde önemli bir rol oynamaktadır. Bu çalışma, teleradyoloji alanındaki makalelerin bibliyometrik göstergeler ve içerik olarak analiz edilmesini amaçlamaktadır. Teleradyoloji ile ilgili Web of Science veri tabanında yer alan 960 makale "anahtar kelimeler, yayın türü ve yayın dili" kriterleri kullanılarak araştırmaya dâhil edilmiştir. Araştırma, 1991-2024 yılları arasında 503 dergide, 92 ülkeden 4.734 yazar tarafından İngilizce olarak yayınlanan 960 makaleyi kapsamaktadır. Teleradyoloji alanındaki yayınlar yıllar itibariyle artmakta, en çok makale yayınlayan ülke "ABD", üniversite "University of Maryland", dergi "Journal of Digital Imaging", yazarlar "B. A. M. Bandowe, M. A. Brondani ve K. Dreij", en çok atıf alan yazar ise "B. A. M. Bandowe" olmuştur. Yayınlanan makalelerde en çok "PACS" olmak üzere 2.851 farklı anahtar kelime kullanılmıştır. Araştırma kapsamına alınan ve en çok atıf alan 33 (≥50) makalede, "teleradyolojinin faydaları", "teleradyolojinin maliyeti", "teleradyolojiye ilişkin sorunlar" ve "teleradyolojinin benimsenmesi, kullanımı ve geliştirilmesine yönelik öneriler" olmak üzere dört ana temaya odaklanılmıştır. Araştırmada bibliyometrik ve içerik analiz yapılarak teleradyoloji ile ilgili makalelerin profili, tematik yönelimleri, araştırma öncelikleri incelenmiş ve konu ile ilgili genel bir çerçeve oluşturulmaya çalışılmıştır.

Anahtar Kelimeler: Teleradyoloji, PACS, Radyoloji, Radyolog, Bibliyometrik Analiz

Abstract

Teleradiology, as part of telemedicine, refers to the ability to perform diagnostic examinations even when the location of the images and the radiologist evaluating these images is in different places. Teleradiology has become an integral part of radiology practices and plays an important role in remote imaging and assessment processes. This study aims to analyze articles in the field of teleradiology in terms of bibliometric indicators and content. 960 articles on teleradiology in the Web of Science database were included in the study using the criteria of "keywords, publication type, and publication language". The study covers 960 articles published in English by 4,734 authors from 92 countries in 503 journals between 1991-2024. Publications in the field of teleradiology have been increasing over the years, the country that published the most articles was "USA", the university was "University of Maryland", the journal was "Journal of Digital Imaging", the authors were "B. A. M. Bandowe, M. A. Brondani, and K. Dreij", and the most cited author was "B. A. M. Bandowe". In the published articles, 2,851 different keywords were used, the most frequently being "PACS". The 33 (≥50) most cited articles included in the scope of the research focused on four main themes: "benefits of teleradiology", "cost of teleradiology", "problems related to teleradiology", and"suggestions for the adoption, use, and development of teleradiology". In the research, a general framework was created for the profile, thematic orientations, and research priorities of articles related to teleradiology by conducting bibliometric and content analysis.

Keywords: Teleradiology, PACS, Radiology, Radiologist, Bibliometric Analysis

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1. GİRİŞ

Radyoloji, Wilhelm Roentgen'in 1895'te yaptığı teknolojik bir keşif üzerine kurulmuştur. Tanısal radyoloji, yaralanma ve hastalıkları teşhis ve tedavi etme açısından tıbbın gözü haline gelmiştir. Teleradyolojinin kökleri, radyografik görüntülerin telefon hatları üzerinden başarılı bir şekilde iletildiği 1947'ye dayanmaktadır. Teleradyoloji, uzaktan görüntüleme ve yorumlama için görüntülerin elektronik olarak kaydedilmesi, iletilmesi, depolanması ve geri alınmasına dayanmaktadır (Bashshur vd., 2016, ss. 868).

Tarihsel olarak, teleradyolojinin temel itici gücü, acil vakalar için mesai saatleri dışında radyoloji hizmeti ihtiyacının duyulmasıdır. Bununla birlikte, özellikle yerel radyolojinin olmadığı veya yetersiz olduğu durumlarda, uygun koşullar altında önemli bir rolü olduğu açıktır. Ancak, günümüzde bazı kuruluşlar teleradyolojiyi rutin yorumlar için de kullanmaktadır. Teletıp ve teleradyoloji uygulamaları 1990'lı yıllardan itibaren gelişmekte ve önemli yatırımlar yapılmaktadır (Perednia ve Allen, 1995, ss. 483; Craig ve Patterson, 2005, ss. 3). Teleradyoloji, yaygın olarak kullanılan tek teletıp uygulamasıdır. Diğer teletıp uygulamaları yaygın kullanım için umut vadeden adaylar gibi görünse de erken benimseme aşamasında kalmaya devam etmektedir (Zanaboni ve Wootton, 2012, ss. 1).

Teleradyoloji, radyologların kırsal ve uzak bölgelerde konsültasyonunu almayı mümkün kılar ve hastaneler arasında görüntülerin iletilmesine olanak tanır (Paakkala vd., 1991, ss. 157). Radyoloji bölümleri tarafından Görüntü Arşivleme ve İletişim Sistemleri (PACS) ve dijital sistemlerin yaygın olarak benimsenmesi ve yüksek hızlı veri iletimine izin veren yüksek bant genişliklerinin giderek daha fazla kullanılabilir hale gelmesi, bir teleradyoloji hizmet modelinin geliştirilmesini mümkün kılmıştır. Teletıbbın bir alt türü olan teleradyoloji, yorumlayan radyoloğun bulunduğu yerden farklı bir konumda elde edilen tanısal görüntüleri yorumlama uygulamasıdır. Telekomünikasyon sistemleri aracılığıyla farklı konumlar arasında tanısal görüntülerin iletilmesini içeren teleradyoloji, radyoloji uygulamalarının vazgeçilmez bir parçası haline gelmiştir (Binkhuysen ve Ranschaert, 2011, ss. 205).

Hastalara ilişkin sağlık bilgileri, elektronik kayıtlar haline getirildikçe dünyanın her yerinden yetkili tıbbi personel tarafından erişilebilmektedir. Teleradyoloji, internet aracılığıyla görüntülere ve hasta bulgularına erişmeyi, herhangi bir bilgisayarda herhangi bir konumda radyolojik raporlara göz atmayı, görüntülemeyi ve yazmayı mümkün hale getirmiştir. Ayrıca teleradyoloji öğrencilere, doktorlara ve sağlık personeline teşhis, konsültasyon, eğitim ve bilimsel araştırma için yeni ve güçlü araçlar sunmaktadır (Babic, Milosevic ve Babic, 2012, ss. 145).

Teknoloji ve sağlık hizmetlerindeki hızlı değişimler, teletıbbın ve teleradyolojinin gelecekteki uygulamalardaki rolünü tahmin etmeyi zorlaştırmaktadır. Bu araştırmada, teleradyoloji alanındaki makalelerin bibliyometrik ve içerik olarak analiz edilmesi amaçlanmaktadır. Bilimsel yayınların bibliyometrik ve içerik olarak analiz edilmesi, bilimsel alanların araştırma eğilimlerini takip etmede önemli bir adımdır (Stojanowski ve Buikstra, 2005, ss. 98). Bibliyometrik yöntemler belirli bir alandaki bilimsel literatürün genel resmini "kuş bakışı" değerlendirmek için kullanılmaktadır (Börner, Chen ve Boyack, 2005, ss. 180). İçerik analizi, araştırmacının belirli bir alandaki büyümeyi göstermek, ilgi alanlarını ve olası ihmal edilmiş araştırma alanlarını belirlemek, büyük miktarda bilgiyi düzenlemek ve kaynakların tematik sürecini incelemek için yapılmaktadır (Blancher, Buboltz ve Soper, 2010,

ss. 139-140). Araştırmada bibliyometrik ve içerik analizi yapılarak teleradyoloji ile ilgili makalelerin profili, tematik yönelimleri ve araştırma öncelikleri incelenmiştir. Araştırmada teleradyoloji ile ilgili genel bir çerçeve oluşturularak literatüre katkı sunulmaya çalışılmıştır.

2. YÖNTEM

Bu araştırmadaki veriler Web of Science veri tabanından elde edilmiş olup kamuoyuna açık ikincil verilerdir. Bu nedenle araştırma için etik kurul onayı gerekmemektedir. Bu araştırmada, teleradyoloji alanındaki makalelerin bibliyometrik ve içerik olarak analiz edilmesi amaçlanmıştır. Araştırma verileri, 04.09.2024 tarihinde Tablo 1'de verilen arama adımları kapsamında Web of Science veri tabanından elde edilmiştir.

Tablo 1. Araştırmaya dahil etme kriterleri

Arama Adımları	**Yayın Sayısı**
Aranan Anahtar Kelimeler **Konu:** "health" **Tüm Alanlar:** "teleradiology" or "tele-radiology" or "distance at radiology" or "mobile radiology" or "mobile tele-radiology" or "mobile teleradiology" or "video systems" or "images transmission" or "images storage" or "images retrieval" or "PACS" or "out-of-hospital consultation" or "out of hospital consultation"	1.484
Doküman Türü: Makale	1.009
Yayın Dili: İngilizce	960

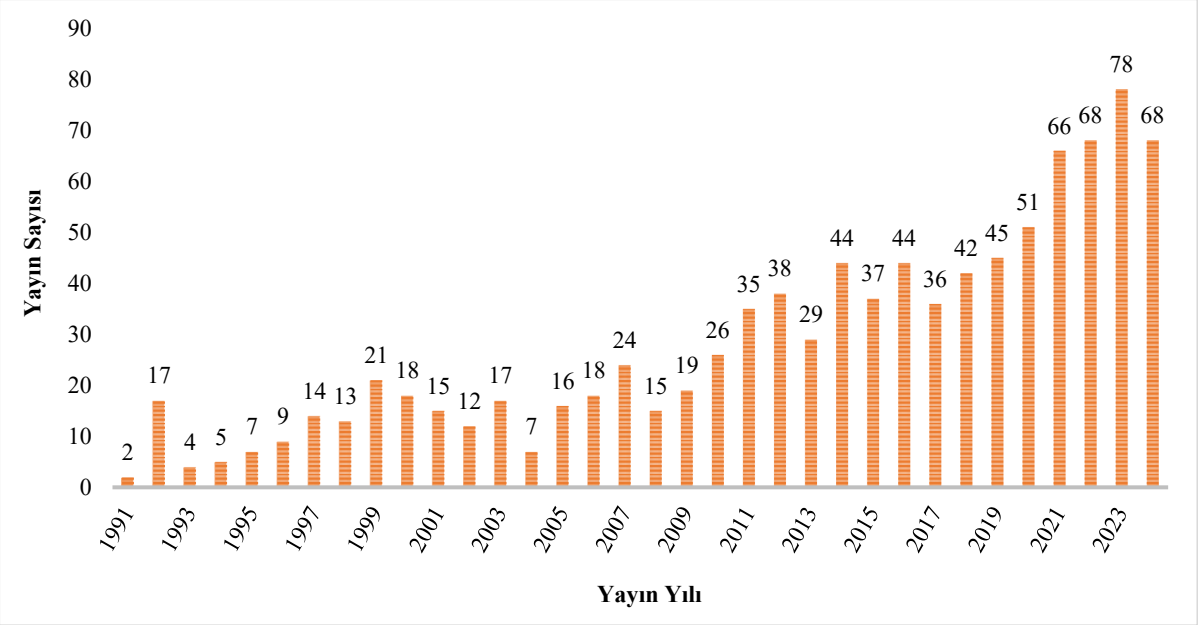
Araştırmaya dahil etme kriterleri; bilimsel yayınların Web of Science veri tabanında yer alması, araştırmacılar tarafından literatür taraması sonucunda belirlenen anahtar kelimeleri içermesi, araştırma makalesi olması ve yayın dilinin İngilizce olmasıdır. Web of Science veri tabanında konu düzeyinde "health", tüm alanlarda "teleradiology" or "tele-radiology" or "distance at radiology" or "mobile radiology" or "mobile tele-radiology" or "mobile teleradiology" or "video systems" or "images transmission" or "images storage" or "images retrieval" or "PACS" or "out-of-hospital consultation" or "out of hospital consultation" anahtar kelimeleri kullanılarak arama yapılmıştır. Araştırmaya dahil etme kriterleri çerçevesinde 1991-2024 yılları arasında İngilizce olarak yayınlanan 960 makale araştırma kapsamına alınmıştır (Tablo 1).

Bibliyometrik yöntemler "yayın, alıntı, yazar, anahtar kelime, ülke ve dergi açısından genel eğilimleri tespit etmek ve ilgili konuya ilişkin genel bir çerçeve sunmak" amacıyla kullanılmaktadır (Martínez-Lopez vd., 2018, ss. 441). Bibliyometrik analizde araştırma kapsamına alınan makaleler "yıl, ülke, üniversite, dergi, yazar, atıf ve anahtar kelime" açısından incelenmiştir. Bibliyometrik verilerin analiz edilmesinde VOSviewer programı kullanılmıştır. Araştırmanın amacı kapsamında 50 ve daha fazla atıf alan 33 makale içerik olarak analiz edilmiştir.

3. BULGULAR

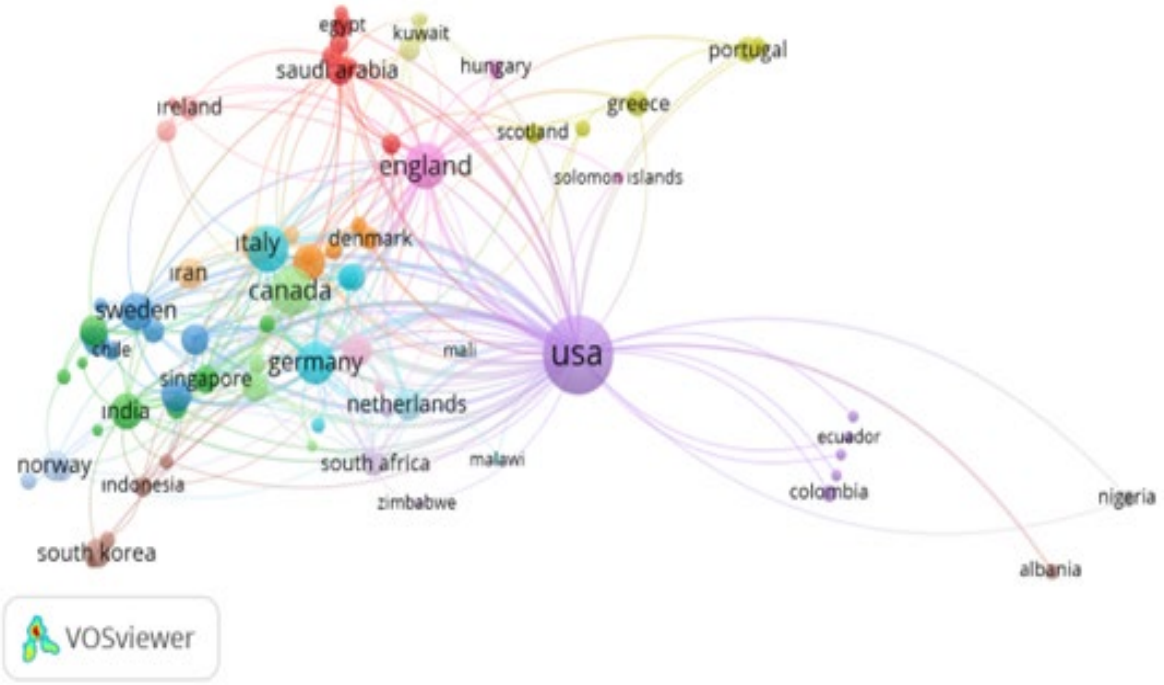
3.1. Bibliyometrik Analiz Bulguları

Web of Science veri tabanında teleradyoloji ile ilgili 04.09.2024 tarihi itibariyle 960 makale bulunmaktadır. Teleradyoloji ile ilgili bilimsel makalelerin sayısında son yıllarda artış görülmektedir. 78 makale ile en çok makale 2023 yılında yayınlanmıştır. Ancak araştırma verileri 2024 yılının Eylül ayında elde edildiği için 2024 yılında teleradyoloji ile ilgili makale sayısının artması muhtemeldir.



Şekil 1: Teleradyoloji ile ilgili makalelerin yıllara göre dağılımı (1991-2024)

Teleradyoloji ile ilgili en çok makale yayınlayan ülkeler sırasıyla; Amerika Birleşik Devletleri (338), Kanada (74), İngiltere (70), Çin (69) ve Almanya (53)'dır. Türkiye 13 makale ile 21. sıradadır (Şekil 2).



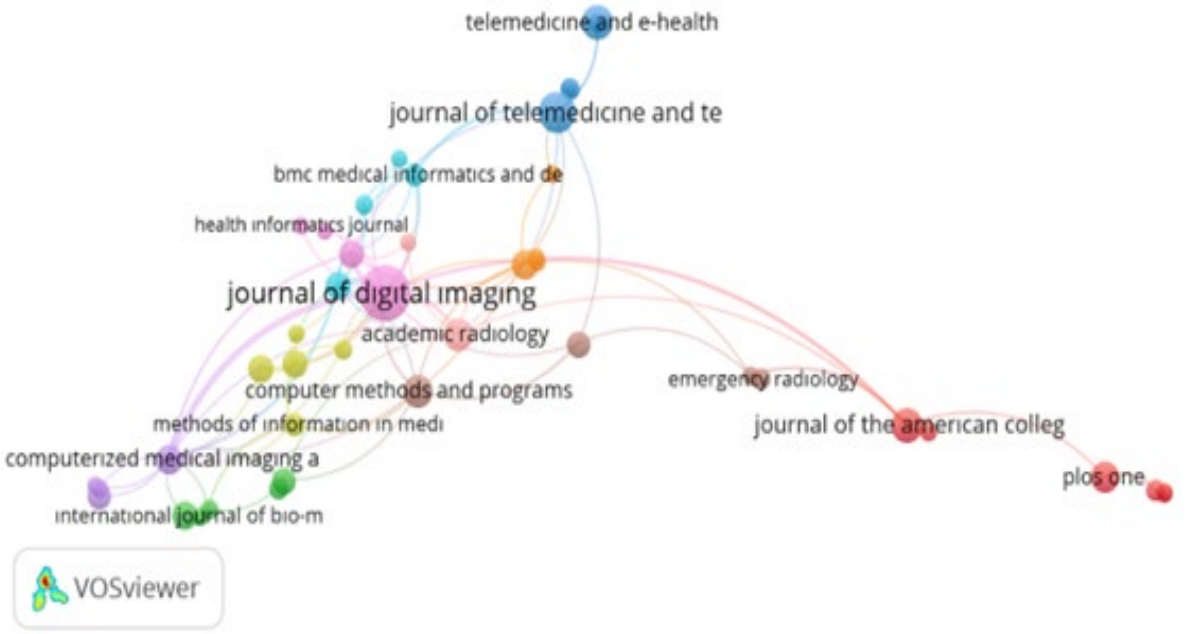
Şekil 2: Teleradyoloji ile ilgili en çok makale yayınlayan ülkeler

Teleradyoloji ile ilgili 1.711 üniversite makale yayınlanmıştır. En çok makale yayınlayan üniversiteler sırasıyla; "University of Maryland" (17), "Mayo Clinic" (16), " University of California San Francisco" (16), "Emory University" (15) ve "Harvard Medical School" (15) olduğu tespit edilmiştir (Tablo 2).

Tablo 2: Teleradyoloji ile ilgili en çok makale yayınlayan üniversiteler (makale sayısı≥10)

Sıra No	Kuruluşlar	Makale Sayısı	Atıf Sayısı
1	University of Maryland	17	514
2	Mayo Clinic	16	525
3	University California San Francisco	16	523
4	Emory University	15	150
5	Harvard Medical School	15	290
6	University of Pennsylvania	14	342
7	Chinese Academy of Sciences	13	491
8	University of Washington	13	380
9	Environment and Climate Change Canada	12	160
10	Massachusetts General Hospital	12	558
11	Stanford University	12	127
12	University of Toronto	12	400
13	University of Arizona	11	155
14	Karolinska Institutet	10	266
15	Rutgers State University	10	408
16	University College London	10	321

Teleradyoloji ile ilgili 503 farklı dergide makale yayınlanmıştır. En çok makale "Journal of Digital Imaging" (87), "Journal of Telemedicine and Telecare" (33), "Journal of the American College of Radiology" (19), "Telemedicine and E-Health" (18) ve "Academic Radiology" (15) dergilerinde yayınlanmıştır (Şekil 3).



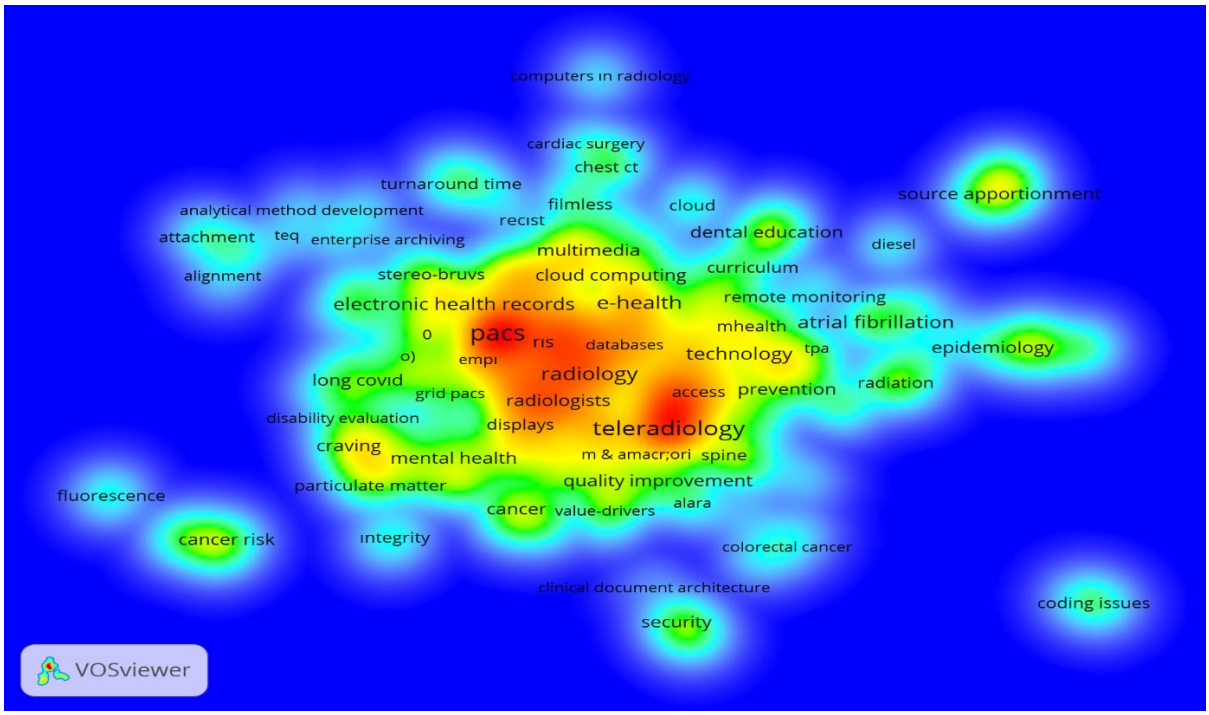
Şekil 3: Teleradyoloji ile ilgili en çok makale yayınlayan dergiler

Teleradyoloji ile ilgili 4734 farklı yazar makale yayınlamıştır. En üretken (en çok makale yayınlayan) yazarlar Benjamin A. Musa Bandowe (6), Mario A. Brondani, (6), Kristian Dreij (6), H. K. Huang (5), Rifat Latifi (5), Daniel J. Mollura (5), Paul Nagy (5), Lee H. Schwamm (5), Jeffrey L. Sunshine (5) ve Wolfgang Wilcke (5) olduğu tespit edilmiştir. Teleradyoloji ile ilgili en etkili (en çok atıf alan) yazarlar ise Benjamin A. Musa Bandowe (579), Wolfgang Wilcke (491), Junji Cao (448) ve Lee H. Schwamm (322) olmuştur (Tablo 3).

Tablo 3: Teleradyoloji ile ilgili en üretken ve en etkili yazarlar

Sıra No	Yazar	Makale Sayısı	Sıra No	Yazar	Atıf Sayısı
1	B. A. Musa Bandowe	6	**1**	B. A. Musa Bandowe	579
2	Mario A. Brondani	6	**2**	Wolfgang Wilcke	491
3	Kristian Dreij	6	**3**	Junji Cao	448
4	Hk Huang	5	**4**	Lee H. Schwamm	322
5	Rifat Latifi	5	**5**	Thomas A. Dewland	186
6	Daniel J. Mollura	5	**6**	Susan R. Heckbert	186
7	Paul Nagy	5	**7**	Gregory M. Marcus	186
8	Lee H. Schwamm	5	**8**	Phyllis K. Stein	186
9	Jeffrey L. Sunshine	5	**9**	Eric Vittinghoff	186
10	Wolfgang Wilcke	5	**10**	Richard Wootton	182
11	Thomas A. Dewland	4	**11**	Yongming Han	175
12	Meghan K. Edwards	4	**12**	Chong Wei	175
13	Tarek N. Hanna	4	**13**	Bart M. Demaerschalk	172
14	Susan R. Heckbert	4	**14**	Kristian Dreij	164
15	Elizabeth A.Krupinski	4	**15**	Hk Huang	150
16	Paul D. Loprinzi	4	**16**	Mario A. Brondani	142
17	Gregory M. Marcus	4	**17**	Imad M. Tleyjeh	105
18	Phyllis K. Stein	4	**18**	Rabih Halwani	105
19	Eric Vittinghoff	4	**19**	Peter Schantz	96
20	K. Inamura	4	**20**	Lina Wahlgren	96

Teleradyoloji ile ilgili yayınlanan makalelerde 2.851 farklı anahtar kelime kullanılmıştır. En çok; "PACS", (114), "teleradiology" (82), "telemedicine" (66), "radiology" (29), "DICOM" (26), "telehealth" (25), "covid-19" (24), "e-health" (20), "artificial intelligence" (14), "medical imaging" (11), "MRI" (10) ve "radiology information systems" (10) anahtar kelimeleri kullanılmıştır (Şekil 4).



Şekil 4. Teleradyoloji ile ilgili makalelerde en çok kullanılan anahtar kelimeler

3.2. İçerik Analizi Bulguları

Araştırmada en çok atıf alan 33 makale incelendiğinde; "teleradyolojinin sağladığı faydalar", "teleradyolojinin maliyeti", "teleradyolojiye ilişkin sorunlar" ve "teleradyolojinin benimsenmesi, kullanımı ve geliştirilmesine yönelik öneriler" olmak üzere dört ana temaya odaklanıldığı tespit edilmiştir.

3.2.1. Teleradyolojinin Sağladığı Faydalar

Teleradyoloji alanındaki makaleler içerik olarak incelendiğinde hastalara, sağlık profesyonellerine, sağlık kurumlarına ve genel sağlık sistemine faydalar sağladığı görülmektedir.

Teleradyolojinin hastalara sağladığı faydalar: Teleradyoloji, hastalara uzman sağlık hizmetlerine erişim maliyetini azaltma, hizmetlere erişimi kolaylaştırma, daha kaliteli hizmet alma, ulaşım ve zaman gibi faydalar sağlama potansiyeline sahiptir (Moffatt ve Eley, 2010, ss. 277; Zennaro vd., 2014, ss. 8). Yapılan bir araştırmada teleradyoloji hizmetini kullanırken hastaların ikamet ettikleri yerde kalma olanağından, seyahat süresinin kısa olmasından ve hastane hizmetine kıyasla daha hızlı hizmet süresinden memnuniyet duydukları tespit edilmiştir (Jacobs vd., 2016, ss. 3). Benzer olarak Babic ve arkadaşları (2012, ss. 147) tarafından yapılan araştırmada teleradyoloji kullanımın hastalara alanında uzman radyologlara erişim, radyolojik bulguların ikamet edilen yerdeki sağlık kuruluşlarından seyahat ve konaklama masrafları olmadan kısa sürede elde edilmesi, hastanın işten uzak kalmasını ve belirsizlik yaşamasını en aza indirmesi gibi faydalar sağladığı sonucuna ulaşılmıştır.

Teleradyolojinin radyoloji ve sağlık profesyonellerine sağladığı faydalar: Radyologların iş yükü son yıllarda artmaya devam etmektedir. Bhargavan ve diğerleri (2009, ss. 461) tarafından yapılan araştırmada 1991 yılından 2007 yılına kadar radyolog başına düşen görüntüleme sayısında %34'lük bir artış olduğu tespit edilmiştir. Bu artışa ek olarak mesai dışı teleradyoloji hizmetlerini kullanan radyologlar, diğerlerinden %27 daha fazla görüntü raporlamaktadır. Teleradyoloji, sağlık profesyoneli ile hasta arasındaki mekânsal ve zamansal ilişkiyi kökten değiştirmektedir (May vd., 2001, ss. 1879). Teleradyoloji, radyologların bireysel uzmanlıktan büyük bir ağdaki önemli bir aktör haline gelmesine ve daha fazla uzmanlaşmasına yol açmıştır (Fridell vd., 2007, ss. 411). Teleradyoloji radyologların ve sağlık çalışanlarının sürekli eğitim, deneyimsel öğrenme, ağ kurma ve işbirliği sağlayarak mesleki gelişimlerine katkı sağlayabilir (Moffatt ve Eley, 2010, ss. 277). Ayrıca teleradyoloji radyologlara uzak uzmanlardan destek alma, işbirliği sağlama ve böylece bireysel mesleki ilerleme ve yeterliliği artırma gibi faydalar sağlamaktadır. Teleradyoloji ile radyologların radyolojik görüntüleri okumaları ve radyolojik bulguları yazmaları için uzak yerlere seyahat etme ve konaklamalarına gerek kalmamaktadır (Babic vd., 2012, ss. 147).

Teleradyolojinin sağlık kurumlarına sağladığı faydalar: Tıbbi görüntüleme teknolojileri geliştikçe PACS kullanımı yaygınlaşmaktadır. PACS'ın etkili bir şekilde kullanılması sağlık hizmeti sunumunda operasyonel (iş akışı) verimliliği ve kalitenin artırılması, bilgi teknolojilerine entegrasyonu, süreçlerin yenilenmesi ve benimsenmesi gerçekleştirilebilir. Bu ilerlemeyle birlikte, klinisyenler, doktorlar ve hastane yönetiminin zamanında ve doğru bilgi alma düzeyi de artar (Van de Wetering ve Batenburg, 2009, ss. 134). PACS kullanımı, tanısal görüntüleme bölümlerinde var olan verimsizliklerin çoğunu azaltabilir. PACS özellikle radyografinin aynı anda yalnızca bir yerde olabilmesi, filmlerin erişim kısıtlılığı, yanlış yere yerleştirme, kaybolma veya çalınma ihtimallerini ortadan kaldırmaktadır. Ayrıca PACS ile iş akışları yeniden tasarlanarak 59 manuel adımın çoğunun ortadan kaldırılmasıyla birlikte maliyetin düşürülmesinde ve verimliliğin sağlanmasında önemli katkı sunmaktadır (Siegel ve Reiner, 2002, ss. 565). Başarılı PACS uygulaması, radyoloji uygulamasının üretkenliğini ve verimliliğini artırır, nihai raporların teslim sürelerinde azalma sağlar, filmle ilgili maliyetleri ve işçilik giderlerinin azalmasını destekler. Ayrıca film satın alımlarını ve ilgili maliyetleri önemli ölçüde azaltılmasına, kaybolan veya okunmayan filmleri ve çekim tekrar oranını ortadan kaldırılmasına olanak tanır (Mansoori, Erhard ve Sunshine, 2012, ss. 234). Sağlık kurumları teleradyoloji uygulaması ile yerel uzmanlara olan ihtiyacın azalması, kaynak tahsisinin optimize edilmesi, radyologlar için seyahat ve konaklama masraflarının olmaması, sunulan hizmetlerin kalitesinin artması, görüntü saklama ve iletme maliyetinin azalması ve daha fazla kâr gibi fadyalar sağlamaktadır (Babic vd., 2012, ss. 147-148). Teleradyoloji personel yetersizliği ve radyolog bulunmaması gibi sorunlara çözüm olmakla birlikte, uzman radyologlardan görüş alma imkânı sunmasıyla yanlış teşhis ve uygunsuz tedavinin önlenmesine katkı sunmaktadır (Coulborn vd., 2012, ss. 708).

Teleradyolojinin topluma ve genel sağlık sistemine sağladığı faydalar: Teleradyoloji, genel sağlık sistemi için vatandaşların teletıp ve telesağlık yoluyla klinik bakıma erişimine ve klinik bakım kalitesinin geliştirilmesine, kent-kır nüfus arasındaki sağlık eşitsizliklerinin azaltılmasına katkıda bulunabilir (Moffatt ve Eley, 2010, ss. 279). Teleradyoloji, uzak yerlerdeki hastaların hızlı değerlendirilmesi için etkili bir araçtır. Bu yetersiz hizmet alan yerler arasında coğrafi olarak izole kırsal alanlar ve yetersiz radyoloji uzmanı bulunan kent merkezleri yer almaktadır. Teleradyoloji, radyoloji görüntülerinin okunmasına yönelik artan talebin daha iyi karşılanmasını sağlayacaktır (Wechsler vd., 2013, ss. 670). Sonuç olarak, kentsel ve kırsal alanlar arasındaki radyolog açığını kapatmanın bir yolu olarak teleradyoloji kullanılabilir (Paakkala vd., 1991, ss. 157; Matsumoto vd., 2015, ss. 2; Chandramohan vd., 2024, ss. 5).

Teleradyoloji, radyoloji görüntülerinin daha hızlı okunması ve raporlanmasına olanak sağlayarak geri dönüş sürelerini kısaltır (Rosenkrantz, vd., 2019, ss. 1677). Teleradyoloji ile acil servis uygulamalarında, rapor teslim süresinde, erişimde, daha hızlı tedavide, triyajda ve kaynak kullanımında çeşitli iyileştirmeler sağlamıştır (Ratib vd., 2000, ss. 336; Saffle vd., 2009, ss. 361). Craig ve Patterson (2005, ss. 3) ise teletıp ve teleradyolojinin sağlık hizmetine erişimde eşitliği, sağlık bakımının kalitesini ve sağlık hizmeti sunumunun verimliliğini iyileştirme potansiyeline sahip olduğunu belirmektedir. Babic ve arkadaşlarına (2012, ss. 147-148) göre teleradyoloji uygulaması topluma sağlık hizmetlerinin kalitesinin, performansının ve ulaşılabilirliğinin artması, uzak kırsal alanlarda daha iyi sağlık hizmeti sunma olanağı, uzak kırsal alanlarda sağlık personeli istihdamının artması, nüfusun morbidite ve mortalitesinin azalması, işe devamsızlığın en aza indirilmesi ve sağlık merkezlerinin modernizasyonu gibi faydalar sağlamaktadır.

3.2.2. Teleradyolojinin Maliyetler Üzerine Etkisi

Araştırmada içerik analizi yapılan altı makale teleradyoloji ile ilgili maliyetler üzerine odaklanılmıştır. Zennaro ve diğerleri (2014, ss. 8) tarafından yapılan araştırmada, teleradyoloji kullanılarak konsültasyon için görüntülere uzaktan doğrudan erişim sağlanması hekimlerin hastaneye gelme ihtiyacını azalttığı ve sağlık sistemi kaynaklarının daha rasyonel ve verimli kullanılmasını sağladığı sonucuna ulaşılmıştır. Bu durum hekimlerin hastanede nöbetçi olması yerine evden çalışma imkânı sağladığı, ödenen nöbet ücretlerini ve dolayısıyla bakım maliyetlerini düşürdüğü tespit edilmiştir. Collin ve diğerleri (2008, ss. 4-6) PACS'ın uygulanması ile ayakta tedavilerde tekrarlanan röntgen filmlerinde ve yatılı tedavilerde ise bilgisayarlı tomografide azalma sağlanarak maliyet avantajı sağlanabileceğini göstermiştir. Benzer olarak Flanagan ve arkadaşları (2012, ss. 648) tarafından yapılan araştırmada, bölgesel PACS ağlarının kullanılması tekrarlanan görüntüleme oranını, maliyeti ve radyasyon maruziyetini azaltmada yararlı olabileceği sonucuna ulaşılmıştır. Saffle ve arkadaşları (2009, ss. 358) tarafından yapılan araştırmada, kırsaldaki yanık hastaların akut değerlendirilmesinde teleradyolojinin ve teletıbbın kullanılmasının daha düşük maliyetli olduğu tespit edilmiştir. Bir diğer araştırmada ise teleradyoloji yoluyla yerel bir küçük hastanede bilgisayarlı tomografi taraması analizinin ekonomik olarak makul olduğu sonucuna ulaşılmıştır (Plathow vd., 2005, ss. 1025).

Teleradyolojinin sağladığı maliyet tasarrufu bileşenleri arasında, ortadan kaldırılan seyahat, konaklama, hastaneye yatış, tekrar çekim, personel ve yazılıma gerekli yatırım yer almaktadır. Teleradyolojinin kullanımı üniversite hastanesindeki hastane yataklarını boşaltmış ve bu yataklar yeni hastalar için kullanılabilir hale gelmiştir. Teleradyolojinin sağlık tesislerinin daha verimli kullanılmasına ve maliyet tasarrufunun sağlanmasına yol açabileceği sonucuna varılmıştır (Pedersen vd., 2005, ss. 1364).

3.2.3. Teleradyolojiye İlişkin Sorunlar

Teleradyolojinin başarılı bir şekilde uygulanabilmesi ve fayda elde edilebilmesi için etik ve adli tıp endişeleri, değişime direnç, altyapı eksikliği, dil farklılıkları ve okuma yazma bilmeme gibi insani, kültürel, teknik ve örgütsel faktörler dikkate alınmalıdır (Craig ve Patterson, 2005, ss. 9). Teleradyolojinin potansiyel faydaları kolayca algılanabilse de güvenilir ve tam işlevli sistemleri uygulamak her zaman kolay olmamıştır. Teleradyoloji için tıbbi görüntüleri bilgi sistemlerine entegre etmek ve filmleri uygun maliyetli bir şekilde dijitalleştirmek gibi zorluklar bulunmaktadır (Ratib vd., 2000, ss. 339). Teleradyoloji için en yaygın zorluklar; hastaların sağlık kayıtlarına erişim, önceki görüntüleme tetkiklerine erişim ve görüntü kalitesi güvencesiyle ilgili endişelerdir (Alahmad vd., 2024, ss. 2085). Acil serviste yapılan radyolojik incelemelerde teleradyoloji uygulaması kullanılırken dijital görüntülerin yetersizliği ve görüntü okuyucu hataları nedeniyle görüntü yorumlamasında klinik olarak

anlamlı tutarsızlıklar meydana gelebilmektedir (DeCorato, Kagetsu ve Ablow, 1995, ss. 1295). Teleradyoloji ve PACS uygulamasının başlangıç aşamasında ağ ve bant genişliği sorunlarının ve tedarikçinin ihtiyaçları karşılamasına yönelik sorunların ortaya çıkması muhtemeldir (Mansoori vd., 2012, ss. 233).

Teleradyolojinin uygulanmasında teknolojik altyapı sorunlarının yanısıra kullanıcılardan ve örgütten kaynaklı sorunlar da bulunmaktadır. Teleradyolojiye yönelik kullanıcıların önyargıları, kullanıma yönelik olumsuz tutumlar ve iletişim eksikliği gibi sorunlar ortaya çıkmaktadır (Mansoori vd., 2012, ss. 230). Bütçe eksikliği, yetersiz altyapı ve kullanıcıların yeterli beceriye sahip olmaması gibi kritik organizasyonel zorluklar da bulunmaktadır (Nigatu vd., 2024, ss. 2). Teleradyoloji sistemlerinin kullanılmasında finansman, uygun zaman, son kullanıcının katılımı, satıcının seçimi, kullanılacak sistemin seçimi ve özellikleri, kullanım kolaylığı, sistem kullanımına yönelik eğitim, sistemin son kullanıcı tarafından benimsenmesi ve kullanılması gibi aşılması gereken birçok engel bulunmaktadır. Teknik ve finansal engeller bulunmakla birlikte özellikle insan kaynaklı engelleri aşmak genellikle daha zordur (Duyck vd., 2010, ss. 73).

Tıbbi görüntü güvenliği, dijital görüntüler ve ilgili hasta bilgileri genel ağlar üzerinden iletildiğinde önemli bir konu haline gelmektedir. Sağlık verilerinin güvenliğini sağlamaya yönelik zorunluluklar, sağlık kuruluşları hasta bilgilerinin yalnızca mesleki ihtiyacı olan kişilere ulaşmasını sağlamak için uygun önlemleri almakla yükümlüdür. Görüntü iletişimleri giderek açık ağlar üzerinden genişledikçe ve hastaneler sağlık verisi güvenliğini sağlamak için hükümet emirleri ve güvenlik yönergeleri tarafından zorlandığından, PACS ortamında tıbbi görüntü güvenliği acil bir sorun haline gelmiştir (Cao, Huang ve Zhou, 2003, ss. 185). Teleradyoloji ile ilgili önemli bir sorun da kalite standartlarına, verilerin korumasına ve gizliliğine yönelik düzenlemelerin yetersizliğidir (Chandramohan vd., 2024, ss. 1).

Legido-Quigley ve arkadaşları (2014, ss. 160) tarafından yapılan bir araştırmada, teleradyoloji hizmetlerinin sunulması ve genişletilmesinin önündeki engeller arasında, malpraktis durumunda sorumluluk konusundaki belirsizlik, veri güvenliği, standart dışı sözleşmeler, kalite raporlama sistemleri, sağlık bakım sistemi ve kültürel farklılıklar yer aldığı tespit edilmiştir. Tüm bunlara ek olarak radyologlar, sevk eden klinisyenlerle etkileşime girememelerinin önemli bir sorun olduğunu belirtmişlerdir. Teleradyoloji uzaktan iletim, görüntü saklama, dolandırıcılık, mahremiyet, malpraktis sorumluluğu gibi çeşitli etik ve yasal sorunları gündeme getirmektedir. Bu sorunları ele almak için ortak bir parmak izi/şifreleme/çift filigranlama sistemi kullanılabilir (Viswanathan ve Krishna, 2014, ss. 753). Teleradyoloji uygulamalarında güvenlik, gizlilik, mahremiyet, etkinlik ve maliyet etkinliği öncelikli olmalı ve teknolojik gelişmeler takip edilerek gerekli güncellemeler yapılmalıdır (Perednia ve Allen, 1995, ss. 487).

3.2.4. Teleradyolojinin benimsenmesi, kullanılması ve geliştirilmesi için öneriler

Teletıbbın ve teleradyolojinin belirli durumlarda etkili olduğuna yönelik kanıtlar bulunmaktadır. Ancak, hükümetler ve sağlık kuruluşları teletıbbın gelişimini teşvik etmek için stratejiler üretmezlerse teletıbbın maksimum düzeyde kullanıldığı bir dünyaya geçiş gerçekleşmeyecektir (Craig ve Patterson, 2005, ss. 8). Murray ve arkadaşları (2011, ss. 10) e-sağlık girişimlerinin başarılı bir şekilde benimsenmesini ve uygulanmasını teşvik eden veya engelleyen faktörleri araştırmışlardır. Yeni teknolojinin, uygulayıcıların profesyoneller ve hastalar ile farklı profesyonel gruplar arasındaki etkileşimler üzerinde olumlu bir etkisi olduğunu algıladıkları ve mevcut personelin organizasyonel hedefleri ve beceri setleriyle iyi uyum sağladığı yerlerde benimseme ve kullanma olasılığı artmaktadır. Ancak uygulayıcıların bu alanlardan bir veya daha fazlasında sorun algılamaları, benimseme ve kullanma olasılıklarını

düşürmektedir. Shah ve diğerleri (2015, ss. 1) araştırmalarında en önemli eksikliğin eğitim eksikliği olduğu sonucuna ulaşmışlardır.

Teletıbbın yaygın olarak benimsenmesinde hala zorluklar bulunmaktadır. Teletıp ve teleradyolojinin benimsenmesinde dört temel faktör etkilidir. İlk olarak, kullanıcılar için sağladığı avantajlar sağlık hizmetlerinde teknolojinin benimsenme hızının belirleyicisidir. İkinci olarak, teknoloji benimsenmesi, benimseyenlerin bir teknolojiyi farklı zamanlarda kullanmaya karar verdiği S şeklinde bir lojistik büyüme eğrisini takip etme eğilimindedir. Üçüncüsü, bir teletıp uygulamasının topluma sağladığı avantajların ve maliyet etkinliğinin kanıtlanması gereklidir. Dördüncüsü, teletıbbın yaygın olarak benimsenmesi için sağlık profesyonellerine yönelik kişisel teşvikler sağlanmalıdır (Zanaboni ve Wootton, 2012, ss. 6-7).

Teleradyoloji sistemlerini sağlık profesyonellerinin kullanma niyeti üzerinde kullanıcıların olumlu tutumlarının olması, sistemden elde ettikleri faydaların farkında olmaları ve sistemi kullanırken ortaya çıkan sorunlarda hızlı destek alabilmelerinin önemli etkisi bulunmaktadır (Duyck vd., 2010, ss. 79). Kullanıcı özellikleri, algılanan yararlılık ve algılanan kullanım kolaylığı PACS kullanıcı kabulünde önemli etkileri bulunmaktadır (Aldosari, 2012, ss. 604). Hekimler, PACS'ın performanslarını artırdığına, teleradyoloji için gereken becerilere sahip olmak için çok fazla zaman harcamak zorunda kalmayacaklarına inanırlarsa ve sosyal çevrelerinden teşvik edildiklerini algılarlarsa PACS kullanımını ve teleradyolojiyi kabul etme olasılıkları artmaktadır (Pynoo vd., 2012, ss. 95). Teknolojik değişimlere hazır bulunuşluk, iyimserlik ve yeniliklere açık olmanın yanı sıra algılanan kullanım kolaylığı ve algılanan faydalılık sağlık profesyonellerinin teleradyolojiyi kullanma niyeti üzerinde olumlu etkisi bulunmaktadır (Nigatu vd., 2024, ss. 16-17).

Teleradyoloji, görüntülerin elde edildiği yerden uzakta radyoloji hizmetlerinin sağlanması anlamına gelmektedir. Teleradyoloji, radyoloji hizmetlerinin geniş yelpazesinin bir parçası olmalı ve bu yelpazeye entegre edilmeli, ayrı bir alınıp satılabilir meta olmamalıdır. Teleradyoloji tarafından sunulan radyolojik raporların ve hizmetlerin kalitesi, yerel radyologlarınkinden daha düşük olmamalıdır. Teleradyoloji için uluslararası kalite standartları oluşturulmalıdır. Teleradyolojinin kullanılacağı durumlarda hastaların tam olarak bilgilendirilmesi gerekmektedir (European Society of Radiology /ESR, 2014, ss. 1).

4. SONUÇ

Bu araştırmada Web of Science veri tabanında yer alan teleradyoloji ile ilgili makaleler bibliyometrik ve içerik olarak analiz edilmiştir. Bibliyometrik analizden elde edilen bulgulara göre; teleradyoloji ile ilgili makalelerin yıllar itibariyle arttığı, en çok makalenin ülke olarak "ABD, Kanada, İngiltere, Çin ve Almanya"; üniversite olarak "University of Maryland, Mayo Clinic, University of California San Francisco, Emory University ve Harvard Medical School" ; dergi olarak "Journal of Digital Imaging, Journal of Telemedicine and Telecare, Journal of the American College of Radiology, Telemedicine and E-Health ve Academic Radiology"; yazar olarak "Benjamin A. Musa Bandowe, Mario A. Brondani ve Kristian Dreij" tarafından yayınlanmıştır. İlgili makalelerde en çok "PACS, teleradiology, telemedicine, radiology, DICOM, telehealth, covid-19, e-health, artificial intelligence, medical imaging, MRI ve radiology information systems" anahtar kelimeleri kullanılmıştır. Bu bibliyometrik analiz teleradyoloji ile ilgili araştırma akışını ve makalelerin profilini ortaya koymaktadır.

Araştırmada 50 ve üzeri atıf alan 33 makale içerik olarak incelendiğinde; teleradyolojinin hastalara, radyoloji ve sağlık profesyonellerine, sağlık kurumlarına, topluma ve genel sağlık sistemine sağladığı faydalar, teleradyolojinin maliyetler üzerine etkileri, teleradyolojiye ilişkin sorunlar ve teleradyolojinin benimsenmesi, kullanımı ve geliştirilmesine yönelik öneriler üzerine odaklanıldığı sonucuna ulaşılmıştır. İçerik analizi ile teleradyoloji alanındaki bilimsel makalelerin tematik yönelimleri ve araştırmada vurgulanan konular belirlenmiştir. Araştırmada bibliyometrik ve içerik analizi yapılarak teleradyoloji alanındaki gelişmelerin genel bir çerçevesi ortaya konulmaya çalışılmıştır.

Etik Kurul Onayı

Araştırmada Web of Science veri tabanından elde edilmiş olup kamuoyuna açık ikincil veriler kullanıldığı için etik kurul onayı gerekmemektedir.

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5. KAYNAKLAR

Alahmad, H., Almanaa, M. A., Abanomy, A., Alarifi, M., Alenazi, K., Matabi, M., Albathi, R., Moslem, R. (2024). Navigating Challenges in Teleradiology Implementation: A Case Study from Saudi Arabias Healthcare System. Journal of Multidisciplinary Healthcare, 17, 2083 - 2092. https://doi.org/10.2147/JMDH.S460547.

Aldosari, B. (2012). User Acceptance of a Picture Archiving and Communication System (PACS) in a Saudi Arabian Hospital Radiology Department. *BMC Medical Informatics and Decision Making, 12*, 1-10. https://doi.org/10.1186/1472-6947-12-44.

Babic, R., Milosevic, Z., Babic, G. S. (2012). Teleradiology - Radiology at Distance. *ACta Facultatis Medicae Naissensis, 29(3)*, 145-151. https://doi.org/10.2478/v10283-012-0020-8.

Bashshur, R. L., Krupinski, E. A., Thrall , J. H., Bashshur, N. (2016). The Empirical Foundations of Teleradiology and Related Applications: A Review of the Evidence. *Telemedicine Journal and E-Health, 22(11)*, 868-898. https://doi.org/10.1089/tmj.2016.0149.

Bhargavan, M., Kaye, A. H., Forman, H. P., Sunshine, J. H. (2009). Workload of Radiologists in United States in 2006–2007 and Trends Since 1991–1992. *Radiology, 252(2)*, 458-467. https://doi.org/10.1148/radiol.2522081895

Binkhuysen, F. B., Ranschaert, E. R. (2011). Teleradiology: Evolution and Concepts. *European Journal of Radiology, 78(2)*, 205-209. https://doi.org/10.1016/j.ejrad.2010.08.027

Blancher, A., Buboltz, W. C., Soper, B. (2010). Content Analysis of the Journal of Counseling & Development: Volumes 74 to 84. *Journal of Counseling & Development, 88(2)*, 139-145. https://doi.org/10.1002/j.1556-6678.2010.tb00002.x.

Börner, K., Chen, C., Boyack, K. W. (2005). Visualizing Knowledge Domains. *Annual Review of Information Science and Technology, 37(1)*, 179–255. https://doi.org/10.1002/aris.1440370106.

Cao, F., Huang, H. K., Zhou, X. Q. (2003). Medical Image Security in a HIPAA Mandated PACS Environment. *Computerized Medical Imaging and Graphics, 27(2-3)*, 185-196. https://doi.org/10.1016/S0895-6111(02)00073-3

Chandramohan, A., Krothapall, V., Augustin, A., Kandagaddala, M., Thomas, H. M., Sudarsanam, T. D., Jagirdar, A., Govil, S., Kalyanpur, A. (2024). Teleradiology and Technology Innovations in Radiology: Status in India and its Role in Increasing Access to Primary Health Care. *Lancet Regional Health - Southeast Asia, 23*, 1-14. https://doi.org/10.1016/j.lansea.2023.100195.

Collin, S., Reeves, B. C., Hendy, J., Fulop, N., Hutchings, A., Priedane, E. (2008). Implementation of Computerised Physician Order Entry (CPOE) and Picture Archiving and Communication Systems (PACS) in the NHS: Quantitative Before and After Study. *BMJ-British Medical Journal, 337(7670)*, 1-8. https://doi.org/10.1136/bmj.a939.

Coulborn, R. M., Panunzi, I., Spijker, S., Brant, W. E., Duran, L. T., Kosack, C. S., Murowa, M. M. (2012). Feasibility of Using Teleradiology to Improve Tuberculosis Screening and Case Management in a District Hospital in Malawi. *Bulletin of the World Health Organization, 90(9)*, 705-711. https://doi.org/10.2471/BLT.11.099473.

Craig, J., Patterson, V. (2005). Introduction to the Practice of Telemedicine. *Journal of Telemedicine and Telecare, 11(1)*, 3-9. https://doi.org/10.1258/1357633053430494.

DeCorato, D. R., Kagetsu, N. J., Ablow, R. C. (1995). Off-hours Interpretation of Radiologic Images of Patients Admitted to the Emergency Department: Efficacy of Teleradiology. *American Journal of Roentgenology, 165(5)*, 1293-1296. https://doi.org/10.2214/ajr.165.5.7572522.

Duyck, P., Pynoo, B., Devolder, P., Voet, T., Adang, L., Ovaere, D., Vercruysse, J. (2010). Monitoring the PACS Implementation Process in a Large University Hospital—Discrepancies Between Radiologists and Physicians. *Journal of Digital Imaging, 23*, 73-80. https://doi.org/10.1007/s10278-008-9163-7.

European Society of Radiology (ESR). (2014). ESR White Paper on Teleradiology: An Update from the Teleradiology Subgroup. *Insights into Imaging, 5*, 1-8. https://doi.org/10.1007/s13244-013-0307-z.

Flanagan, P. T., Relyea-Chew, A., Gross, J. A., Gunn, M. L. (2012). Using the Internet for Image Transfer in a Regional Trauma Network: Effect on CT Repeat Rate, Cost, and Radiation Exposure. *Journal of the American College of Radiology, 9(9)*, 648-656. https://doi.org/10.1016/j.jacr.2012.04.014.

Fridell, K., Edgren, L., Lindsköld, L., Aspelin, P., Lundberg, N. (2007). The Impact of PACS on Radiologists' Work Practice. *Journal of Digital Imaging, 20*, 411-421. https://doi.org/10.1007/s10278-006-1054-1.

Jacobs, J. W., Ekkelboom, R., Jacobs, J. A., Van der Molen, T., Sanderman, R. (2016). Patient Satisfaction with a Teleradiology Service in General Practice. *BMC Family Practice, 17*, 1-8. https://doi.org/10.1186/s12875-016-0418-y.

Legido-Quigley, H., Doering, N., McKee, M. (2014). Challenges Facing Teleradiology Services Across Borders in the European Union: A Qualitative Study. *Health Policy and Technology, 3(3)*, 160-166. https://doi.org/10.1016/j.hlpt.2014.04.001.

Mansoori, B., Erhard, K. K., Sunshine, J. L. (2012). Picture Archiving and Communication System (PACS) Implementation, Integration & Benefits in an Integrated Health System. *Academic Radiology, 19(2)*, 229-235. https://doi.org/10.1016/j.acra.2011.11.009.

Martínez-Lopez, F. J., Merigo, J. M., Valenzuela-Fernández, L., Nicolás, C. (2018). Fifty years of the European Journal of Marketing: A Bibliometric Analysis. *European Journal of Marketing, 52(1/2)*, 439-468. https://doi.org/10.1108/EJM-11-2017-0853.

Matsumoto, M., Koike, S., Kashima, S., Awai, K. (2015). Geographic Distribution of Radiologists and Utilization of Teleradiology in Japan: A Longitudinal Analysis Based on National Census Data. *Plos One, 10(9)*, 1-14. https://doi.org/10.1371/journal.pone.0139723.

May, C., Gask, L., Atkinson, T., Ellis, N., Mair, F., Esmail, A. (2001). Resisting and Promoting New Technologies in Clinical Practice: The Case of Telepsychiatry. *Social Science & Medicine, 52(12)*, 1889-1901. https://doi.org/10.1016/S0277-9536(00)00305-1.

Moffatt, J. J., Eley, D. S. (2010). The Reported Benefits of Telehealth for Rural Australians. *Australian Health Review, 34(3)*, 276-281. https://doi.org/10.1071/AH09794.

Murray, E., Burns, J., May, C., Finch, T., ODonnell, C., Wallace, P., Mair, F. (2011). Why is it Difficult to Implement E-health Initiatives? A Qualitative Study. *Implementation Science, 6(6)*, 1-11. https://doi.org/10.1186/1748-5908-6-6.

Nigatu, A. M., Yilma, T. M., Gezie, L. D., Gebrewold, Y., Gullslett, M. K., Mengiste, S. A., Tilahun, B. (2024). Health Professionals Technology Readiness on the Acceptance Of Teleradiology in the Amhara Regional State Public Hospitals, Northwest Ethiopia: Using Technology Readiness Acceptance Model (TRAM). *Plos One, 19(3)*, 1-21. https://doi.org/10.1371/journal.pone.0301021.

Paakkala, T., Aalto, J., Kahara, V., Seppanen, S. (1991). Diagnostic Performance of a Teleradiology System in Primary Health Care. *Computer Methods and Programs in Biomedicine, 36(2-3)*, 157-160. https://doi.org/10.1016/0169-2607(91)90066-3.

Pedersen, M., Aasland, J., Kaspersen, J. H., Leira, H. O., Myhre, H. O. (2005). Teleradiologic Follow up of Patients Treated with Aortic Stent Grafting. *Tidsskr Nor Laegeforen, 125(10)*, 1362-1364.

Perednia, D. A., Allen, A. (1995). Telemedicine Technology and Clinical Applications. *JAMA, 273(6)*, 483–488. https://doi.org/10.1001/jama.1995.03520300057037

Plathow, C., Walz, M., Essig, M., Engelmann, U., Schulz-Ertner, D., Delorme, S., Kauczor, H. U. (2005). Teleradiology: Economic Research Analysis of CT Investigations in a Small Hospital. *Rofo, 177(7)*, 1016-1026. https://doi.org/10.1055/s-2005-858265.

Pynoo, B., Devolder, P., Duyck, W., Van Braak, J., Sijnave, B., Duyck, P. (2012). Do Hospital Physicians' Attitudes Change During PACS Implementation? A Cross-Sectional Acceptance Study. *International Journal of Medical Informatics, 81(2)*, 88-97. https://doi.org/10.1016/j.ijmedinf.2011.10.007.

Ratib, O., Ligier, Y., Bandon , D., Valentino, D. (2000). Update on Digital İmage Management and PACS. *Abdominal Imaging, 25*, 333-340. https://doi.org/10.1007/s002610000011.

Rosenkrantz, A. B., Hanna, T. N., Steenburg, S. D., Tarrant, M. J., Pyatt, R. S., Friedberg, E. B. (2019). The Current State of Teleradiology Across the United States: A National Survey of Radiologists' Habits, Attitudes, and Perceptions on Teleradiology Practice. *Clinical Practice Management, 16(12)*, 1677-1687.

Saffle, J. R., Edelman, L., Theurer, L., Morris , S., Cochran, A. (2009). Telemedicine Evaluation of Acute Burns Is Accurate and Cost-Effective. *The Journal of Trauma: Injury, Infection, and Critical Care, 67(2)*, 358-365. https://doi.org/10.1097/TA.0b013e3181ae9b02.

Shah, S., Bellows, B. A., Adedipe, A. A., Totten, J. E., Backlund, B. H., Sajed , D. (2015). Perceived Barriers in the Use of Ultrasound in Developing Countries. *Critical Ultrasound Journal, 7*, 1-5. https://doi.org/10.1186/s13089-015-0028-2.

Siegel, E., Reiner, B. (2002). Work Flow Redesign: The Key to Success When Using PACS. *American Journal of Roentgenology, 178(3)*, 563-566. https://doi.org/10.2214/ajr.178.3.1780563.

Stojanowski, C. M., Buikstra, J. E. (2005). Research Trends in Human Osteology: A Content Analysis of Papers Published in the American Journal of Physical Anthropology. *American Journal of Physical Anthropology, 128(1)*, 98-109. https://doi.org/10.1002/ajpa.20088.

Van de Wetering, R., Batenburg, R. (2009). A PACS maturity Model: A Systematic Meta-Analytic Review on Maturation and Evolvability of PACS in the Hospital Enterprise. *International Journal of Medical Informatics, 78(2)*, 127-140. https://doi.org/10.1016/j.ijmedinf.2008.06.010.

Viswanathan, P., Krishna, P. V. (2014). A Joint FED Watermarking System Using Spatial Fusion for Verifying the Security Issues of Teleradiology. *IEEE Journal of Biomedical and Health Informatics, 18(3)*, 753-764. https://doi.org/10.1109/JBHI.2013.2281322.

Wechsler, L. R., Tsao, J. W., Levine, S. R., Swain-Eng, R. J., Adams, R. J., Demaerschalk, B. M., Hess, D. C., Moro, E., Schwamm, L. H., Steffensen, S., Stern, B. J., Zuckerman, S. J., Bhattacharya, P., Davis, L. E., Yurkiewicz, I. R., Alphonso, A. L. (2013). Teleneurology Applications: Report of the Telemedicine Work Group of the American Academy of Neurology. *Neurology, 80(7)*, 670-676. https://doi.org/10.1212/WNL.0b013e3182823361.

Zanaboni, P., Wootton , R. (2012). Adoption of Telemedicine: From Pilot Stage to Routine Delivery. *BMC Medical Informatics and Decision Making, 12(1)*, 1-9. https://doi.org/10.1186/1472-6947-12-1.

Zennaro, F., Gross, D., Fascetta, R., Marini, M., Odoni, L., Di Carlo, V., Dibello, D., Vittoria, F., Lazzerini, M. (2014). Teleradiology for Remote Consultation Using Ipad Improves the Use of Health System Human Resources for Paediatric Fractures: Prospective Controlled Study in a Tertiary Care Hospital in Italy. *BMC Health Services Research, 14*, 1-8. https://doi.org/10.1186/1472-6963-14-327.