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LOWER EXTREMITY REVIEW

March 24 / volume 16 / number 3

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A New Kind of Exhibit Hall



MP Mitchell Group

An exhibit booth for Mitchell Group. It features a large screen displaying a baby's face, a counter with two white chairs, and various product displays. Social media icons for Facebook, Twitter, and LinkedIn are visible on the booth's structure.

Ortho-Rite INCORPORATED

An exhibit booth for Ortho-Rite Incorporated. It features four large screens displaying athletic activities and product information. The booth has a modern, light blue design with a counter and two white chairs.

AMER HEALTH CARE X

An exhibit booth for AmeriGee Health Care X. It features a large screen with the 'X' logo and the text 'WHERE COMPRESSION MEETS COMPLIANCE'. The booth has a blue and white design with a counter, two white chairs, and social media icons for Facebook, Instagram, and LinkedIn. A sign on the counter reads 'Podiatrists' #1 Choice Since 2003! Request a FREE Sample Today!'.

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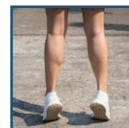
Treating patients with diabetic foot ulcers and lower leg edema requires collaborative care to manage the interplay between these 2 complex conditions.



By Justine Tansley, MRCPod; Richard Collings, PhD, DSc (Hons); Jennifer Williams, BSc (Hons); and Joanne Paton, PhD, MSc

27 STRENGTHENING PROGRAM TO TREAT PLANTAR HEEL PAIN

38 experts review the evidence for muscle-strengthening programs for plantar heel pain and come to consensus.



By John W. A. Osborne, PhDc; Hylton B. Menz, PhD, DSc, BPod(Hons); Glen A. Whittaker, PhD, BPod(Hons); and Karl B. Landorf, PhD

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Lower Extremity Review

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LOWER EXTREMITY REVIEW

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Lower Extremity Review Mission

Showcasing evidence and expertise across multiple medical disciplines to build, preserve, and restore function of the lower extremity from pediatrics to geriatrics.

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- Biomechanics matter
- Injury prevention is possible
- Collaborative care leads to better outcomes
- Movement is essential
- Diabetic foot ulcers can be prevented

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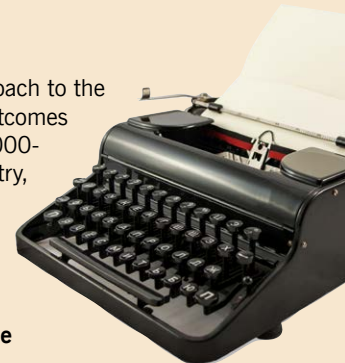
INFORMATION FOR AUTHORS

LER encourages a collaborative multidisciplinary clinical approach to the care of the lower extremity with an emphasis on functional outcomes using evidence-based medicine. We welcome manuscripts (1000-2000 words) that cross the clinical spectrum, including podiatry, orthopedics and sports medicine, physical medicine and rehabilitation, biomechanics, obesity, wound management, physical and occupational therapy, athletic training, orthotics and prosthetics, and pedorthics.

See detailed Author Guidelines at lermagazine.com – click the Editorial tab on the homepage.

ELECTRONIC SUBMISSIONS

Please attach manuscript as an MS Word file or plain text. Tables may be included in the main document, but figures should be submitted as separate jpg attachments. Send to: janice@lermagazine.com



Guest Perspective

National Biomechanics Day 2024 to Build On 2023 International Growth

BY PAUL DEVITA, PHD; LISA MACFADDEN, PHD; AND FELIPE CARPES, PHD



Hello Biomechanists Worldwide...

As we prepare for National Biomechanics Day (NBD) April 3, 2024, we thought a recap of last year's event in order. National Biomechanics Day 2023 celebrated our Breakthrough Science for the eighth consecutive year in 15 countries around the world. Some of our new national friends include Marcus Tilp and Hans Kainz at the University of Vienna in Austria; Elissavet Rousanoglou, National and Kapodistrian University of Athens in Greece; Julius Griškevičius at Vilnius Gediminas Technical University in Lithuania; and Rony Ibrahim from Qatar University.

A few more numbers...in 2023 we had 65 NBD celebrations that introduced biomechanics to ~5,000 high school students and 100 teachers and parents. Our 8-year totals are 557 NBD events in 46 nations hosting more than 40,750 high school students! Talk about breaking through!

Another new thrill for NBD in 2023 was the generous offer from the Journal of Biomechanics Editor Steve Piazza to publish a series of new articles on our favorite world holiday in a special virtual issue titled, "National Biomechanics Day Accelerates The Expansion of the Biomechanics Universe" (available at <https://www.sciencedirect.com/journal/journal-of-biomechanics/special-issue/1034239JR1V>). Nine articles cover topics including increasing diversity, equity, and inclusion in biomechanics; NBDs around the world; an NBD Roadshow; NBDs with dance and sports; plus NBD as informal STEM engagement. Please take a peek at these articles by so many rising stars in Biomechanics and Biomechanics outreach.

NBD, under the auspices of The Biomechanics Initiative, Inc., successfully held its



grant programs for the third consecutive year. We funded 22 applications from 7 nations with \$19,800. These programs supported women, Black, and LatinX students as well as biomechanists working in the area of disability. In 3 years, NBD has provided ~\$50,000 to support the growth and development of our science. We give special acknowledgement to Bertec, Inc, American Society of Biomechanics, and Books of Discovery for their direct support of these programs.

NBD also partnered with Novel Electronics, Inc., for the fourth consecutive year in the "Force the Future loadsol®," contest in which students from the University of Poitiers in France received three pairs of loadsol pro insoles for their NBD celebration. Thanks to Maria Pasquale and Susan Diekrager for their never-ending NBD-enthusiasm.


Along with about a billion fabulous photos from many NBD 2023 celebrations, we also have some outstanding videos which can all be

found at <https://thebiomechanicsinitiative.org/nbd-archives/>.

As always, we cannot accomplish our goals without the support of the scientific and commercial foundations of biomechanics, our many sponsors, all of whom broadly support our science in so many ways.

We again thank the 400+ biomechanists and biomechanics students around the world who participated in National Biomechanics Day 2023. With your continued support, with the support of our sponsors, and with new biomechanists joining NBD each year, we are pretty sure Biomechanics will be the Breakthrough Science of the 21st Century!!!!

And now, on to NBD 2024...

Biomechanics, where science meets fun! 

Celebrating the 21st Century's Breakthrough Science

Biomechanics bridges the gap...

National Biomechanics Day
The Bridge Between
Biomechanics
and Society



2016



2017



2018



2019



2020



2021



2022



2023



2024

...on National Biomechanics Day



National Biomechanics Day April 3, 2024



DRIVING INNOVATION

2023 AOPA NATIONAL ASSEMBLY

INDIANAPOLIS, IN | SEPT 6-9, 2023


#AOPA2023

2023 AOPA Meeting Highlights

UNDERSTANDING WHO WE ARE HELPING

Chronic conditions such as diabetes and peripheral vascular disease were the leading cause of amputation for more than 60% of patients treated at Indiana University Center for Limb Loss (CLL), a Level 1 Trauma Center, according to a new retrospective study.

In looking at the electronic medical records of 218 amputee patients who had been treated at the facility from 2016-2023, researchers found that 61% of amputations were related to chronic conditions compared to 39% related to acute trauma. In terms of sex, both subsets were comprised of approximately $\frac{2}{3}$ male patients. Among patients undergoing amputation for a chronic condition, $\frac{3}{4}$ resided in the Indianapolis metro area compared to $\frac{1}{4}$ residing in outlying rural areas.

In their discussion, the researchers noted that further in-depth analysis of patient demographic data and collection of additional outcome data will help uncover complex contributors to healthcare disparities that impact functional outcomes within the amputee population. Examining differences in functional outcomes related to sex, age, race, and other patient characteristics may reveal potential inequities related to barriers specific to certain subpopulations and thus provide opportunities to be addressed. 

Source: Pratt W, Johnson R, Salin J, Shi E, Altenburger P. Who Are We Helping? Demographic Characteristics of Amputee Population at a Level 1 Trauma, Academic Health Care Center. Poster presented at AOPA 2023 National Assembly; Indianapolis, IN; Sept. 6-9, 2023. Used with permission.

AMPUTEE FOOTBALL BRINGS SOCCER TO EVERY BODY

The US Amputee Football Federation (USAFF) provides participants with an environment and opportunity to regain hope that may have been lost after amputation. Through a sense of teamwork, competitiveness, and achievement, participating in football/soccer allows those with amputations to build physical strength, improve body awareness, balance, and coordination, and develop social skills. This supportive community can serve as a source of motivation for those struggling to manage their disability and integrating into their community, workplace, school, and family. Seeing other amputees play football often instills hope of overcoming personal challenges and pushes participants to achieve their goals. Amputee Footballers often report feeling improved physical and emotional wellbeing, enhanced sense of achievement and competitiveness, and ability to connect with others.

The Federation is looking to develop youth and women's games as well as collegiate leagues with camps and world tours. They hope to partner with professional football/soccer clubs as well as rehabilitation





clinics. Major sponsors include ISPO, Hanger, OttoBock, Ossur, and AWS.

What Is Needed? Crutches, Balls, Boots, Gloves, Jerseys, Cones, Fields

Who is Needed? CPOs, MDs, DPTs, ATCs, Trainers, Coaches, Officials

Want Details? Amputeesoccer.org

Source: Sorrells F, Gilmore M. Spreading HOPE through Therapeutic Recreation. Poster presented at AOPA 2023 National Assembly; Indianapolis, IN; Sept. 6-9, 2023.

ADDITIVE MANUFACTURING IS HERE TO STAY

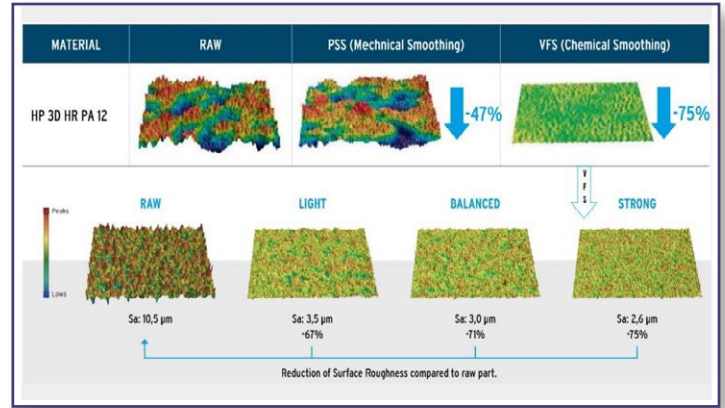
Additively Manufactured Custom Orthotics	Traditionally Manufactured Custom Orthotics
Costs: \$200-\$1,000 (as shoe sizes increase)	Costs: \$476-\$1,053
Lead time: 1-2 weeks	Lead time: 3-4 weeks
Weight: ~.25 kg (ultra lightweight)	Weight: 0.3 - 1 kg
Total contract principle	Total Contact principle with custom parts
High Breathability	Lowered Breathability
Digitized stress flexion response	Stress response constrained to one axis

Figure. Orthotics Analysis

By reducing weight, lead times, and costs, 3-D printing or additive manufacturing (AM) offers significant opportunities for better customization in orthotic and prosthetic development. Today's state-of-the-art scanning technologies allow for the design of components with complex geometries that can improve the functionality of orthoses and prostheses. And high-volume additive manufacturing using multi-jet fusion 3D printers can cost-effectively produce high feature density components in less time than traditional methods (figure).

Source: Marchbanks L. Improving the Quality of Life: Getting Comfortable with Additive Manufacturing. Poster presented at AOPA 2023 National Assembly; Indianapolis, IN; Sept. 6-9, 2023.

POST-PROCESSING TECH PERSONALIZES TO EACH USER'S NEEDS



Surface finishing techniques increase scratch resistance and/or create a sealed, airtight surface therefore removing the porosity from the raw 3D printed part. Image courtesy of Dye Mansion North American Inc.

While 3D printing has dramatically accelerated the customization process for manufacturing orthotics and prosthetics, it's often today's post-processing technologies that make those applications possible. The ability to create washable and sealed surfaces that maintain material properties or the chance to add any color you want – from Pantone to customized skin colors and all of that matching the standards for biocompatibility is a real game changer.

Source: Simpson E. Tailor-Made O&P—How 3D Printing and Post-Processing of Powder Bed Fusion Parts are Setting New Standards in the Medical Industry. Poster presented at AOPA 2023 National Assembly; Indianapolis, IN; Sept. 6-9, 2023.

MANITOBA P&O USERS ENDORSE CERTIFIED CARE...WANT MORE

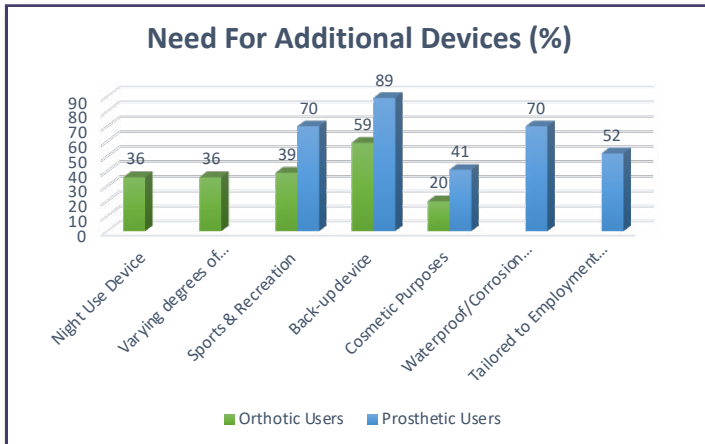
A recent survey found that experienced orthotic and prosthetic (O&P) device users with a chronic disability liked the range of care they received from certified O&P providers, were “very satisfied” with the device-related goals they had achieved, and reported they could not maintain their current level of function without certified P&O providers.

The cross-sectional survey, done by Dan Mazur, MRSc, CPO(c), from the University of British Columbia and Anderson Orthopedics, used Patient-Reported Experience Measures (PREMs) to better understand the impact of certified O&P care on client satisfaction with their device/s as well as with the service provider. Sample size was 95 O&P

Continued on page 10




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users with a chronic disability and mean device history of 10.4 years.

Users reported that their assistive devices improved their effectiveness in daily activities and provided a degree of safety and the associated physical therapy and occupational therapy helped to optimize their overall treatment plans...but access was limited. Users also reported the need for additional devices meeting a range of needs (see figure).

Regarding costs, the survey found that more than one-third of respondents were not able to afford any device/service costs, while less than 10% said they could afford over \$1000. Thus, it is important for funding organizations to provide fully funded device solutions where possible and expand device offerings to better fulfill patient needs. Certified providers must also look for opportunities to collaborate with allied health clinicians in a cost-effective manner to improve efficiency and effectiveness of their P&O treatment plan. It is also of paramount importance for certified providers to lobby funding agencies for increases in both device and service level funding to more adequately reflect modern technological advances and evolving patient needs.

Future research in this area should include a larger sample size with representation of patient sub-groups and generalizability to other practice contexts. Additionally, future investigations could include a qualitative research component to complement a psychometrically tested quantitative instrument to further seek understanding of the lived experience of a prosthetic/orthotic user. 

Source: Mazur D. *An Exploratory analysis of patient reported experience measures in prosthetic and orthotic users treated in Manitoba, Canada.* Poster presented at 50th Annual Meeting & Scientific Symposium of the American Academy of Orthotics and Prosthetics. Chicago, IL. March 6-9, 2024.


PEUDO-PROSTHESIS APPEARS ACCURATE AS TEACHING TOOL

Prosthetic device users have a wide range of needs and prosthetists need to be aware of varying product offerings to meet those needs. Pseudo-protheses allow able-bodied users to understand ambulation in a specific device, providing critical education about new products as well as ongoing training for evolving products.

But how does walking on a transtibial pseudo-prosthesis compare to walking on an actual transtibial prosthetic limb? That's the question researchers from the University of Pittsburgh School of Health and Rehabilitation Sciences asked in a study that was presented as a poster at the 50th Annual Meeting and Scientific Sessions of the American Academy of Orthotists and Prosthetists.

Researchers had 10 able-bodied volunteers perform a battery of outcome tests—6-minute walk test (6MWT), Hill assessment index (HAI), and Stair Assessment Index (SAI)—wearing 2 different prosthetic feet, a Solid Ankle Cushion Heel (SACH) foot and an Energy Storage and Return (ESAR) foot. The 2 options were selected to cover a range of activities.

Two of the 5 test results—the 6MWT and SAI incline/decline—compare well to mobility tests performed with a real prosthetic device. Two other tests—HAI ascending/descending—differed from previous published findings, which the researchers attributed to potential differences in the ramp dimensions.

The team concluded that pseudo-protheses offer a more versatile approach to testing component parts as well as teaching prosthetists. 

Source: Daniels CJ, Fiedler G. *Quantifying the Accuracy of Pseudo-protheses in Relation to Prosthetic Devices Using Different Feet.* Poster presented at 50th Annual Meeting & Scientific Symposium of the American Academy of Orthotics and Prosthetics. Chicago, IL. March 6-9, 2024.

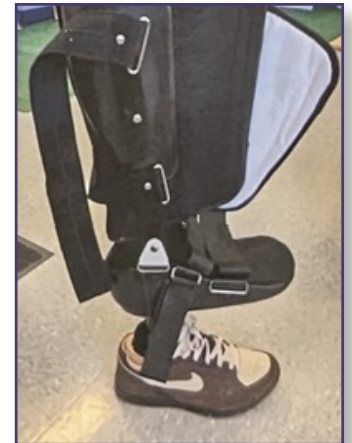


Figure. Typical trans-tibial pseudo prosthesis design.



THE IMPORTANCE OF INTERFACE MATERIALS

COMPARISON - Practical Use of the Data

A fundamental understanding of the way soft interface materials compare to one another provides insight to the clinician and fabricator.

Example: Compare different types of polyurethane and their accompanying reported data. Some data has been collected into the comparison chart on the right (Vis. 1.1). It is apparent that their densities and compression set properties don't vary much, so to the touch they may feel similar. But further examination shows a significant variance in tensile strength, elongation and especially resilience.

When these factors aren't taken into consideration, the default method of choosing a cushioning layer in a foot orthosis, for instance, would perhaps be to choose based on brand, color or touch. Selecting a polyurethane based on that criteria may prove to be a mistake, or at least may not provide the best potential outcome for the patient.

For example, if an accommodating backfill is needed under an ulcer, a material with high elongation and low resilience would be favorable over a material with standard elongation and hi resilience. Using the high resilience urethane in this case may actually increase pressure under the ulcer if the surrounding material has a resilience factor that is less than or equal to that of the backfill.

Similarly, if an athlete suffers from shin splints and deceleration of heel-strike to mid-stance is suggested as a possible remedy, using a cushioning material in the heel that offers low resilience may better suit the athlete than that of high resilience, which may accelerate the heel-strike to mid-stance and have the opposite effect.

Leading researchers and educators in O&P are starting to talk about materials selection differently, and in a way that stresses its importance. Specifically when considering the fabrication of foot orthoses, one may consider material selection in terms of "dosing" as a way to approach support and accommodation for specific pathologies.

HOW TO USE THIS INFORMATION

Product comparison for evaluation of new or substitute materials:

Polymer	Test Method	Educor® Professional Urethane		Compare to PDS®
		Result (US Units)	Result (Metric Units)	Result (Metric Units)
Density	ASTM D1624	11 - 12 g/cc	383.300 kg/m ³	380.000 kg/m ³
Compression Deflection 25%	ASTM D3356	12 - 18 psi	82.7 - 124.1 kPa	45.07 kPa
Compression Set 5%	ASTM D3356	2% Max	2% Max	Not published
Compression Set 10%	ASTM D3356	2% Max	2% Max	Not published
25% CR	ASTM D3356	10.0 psi	72.5 kPa	45.07 kPa
Tensile Strength	ASTM D1624	120 psi	788.40 kPa	488 kPa
Elongation	ASTM D1624	100%	100%	100%
Tear Strength	ASTM D624	14.7 lb./in	2.57 kN/m	0.9 kN/m
Resilience	ASTM D3356	50%	50%	20%
Flammability	FMVSS 302	Pass @ 267° or Higher		Not published
Service Temperature		-40 to 200°F		Not published

The use of select materials in regions of a device to reinforce regional accommodation or support, using the data and testing as a guide for providing intended outcomes:

Vis. 1.1

Polyurethane Comparison

Property	Educor Pro	Educor HR	Educor Impact	Educor SR
Compression Set 5%	~10	~10	~10	~10
Tensile Strength	~110	~70	~70	~50
Elongation	~130	~130	~170	~180
Tear Strength	~10	~10	~10	~10
Resilience	~30	~60	~10	~10

Legend: Educor Pro (Blue), Educor HR (Green), Educor Impact (Yellow), Educor SR (Red)

Compression Set 5% In this group is identical across materials tested so no single sample has a distinct advantage over another. Perhaps an evaluation of 25% CRD would have been more insightful.

Tensile Strength There is a high performer in the Tensile Strength category. If a higher tensile or surface tension factor is important to the management of the pathology, this would be the clear choice.

Elongation In the Elongation category, one material tested is able to stretch to a further percentage of its original size before degradation. This may factor into a device's intended accommodative performance.

Tear Strength There is very little variance in the Tear Strength category, though this is primarily a metric that describes durability. This may or may not factor into a decision on material selection.

Resilience Resilience results show quite a high energy return for one type of material, a middle performer, and two products with very low rebound, which is best in a given scenario or region of the device?

Image courtesy of Acor Orthopaedic, LLC.

CALL FOR MANUSCRIPTS

The Editors of *Lower Extremity Review* want to highlight the work of thoughtful, innovative practitioners who have solved their patients' vexing problems. We are seeking reports of your most intriguing cases in the following areas:

- Biomechanics
- Falls and other injury prevention
- Benefit of movement
- Prevention of diabetic foot ulcers
- Collaborative care

Before you begin to write, query the Editors about your proposed topic (email is fine). Doing so ensures that your manuscript will conform to the mission of the publication and that the topic does not duplicate an article already accepted for publication. Furthermore, a query often allows the Editors and the publication's advisors to make recommendations for improving the utility of the manuscript for readers.

Case reports should be no more than 1500 words (not including references, legends, and author biographies). Photos (≤ 4) are encouraged. Case reports can include a literature review as is appropriate for the topic. (Please note that for HIPPA compliance, photos should be de-identified before sending.)

Manuscripts must be original and not under consideration for publication elsewhere. Any prior publication of material must be explained in a cover letter.

All authors must be medical professionals in good standing. Students will be considered as first author only when the byline includes a fully licensed professional.

Manuscripts are submitted with the understanding that they will be reviewed; that revisions of content might be requested; and that the editorial staff will undertake editing, as necessary, aimed at improving clarity and conciseness and

applying conformity to style. Authors will have the opportunity to review and approve the edited version of their work before publication.

The Editors reserve the right to reject any unsolicited or solicited article that does not meet with editorial approval, including approval denied following requested revision.

Electronic Submission

Please attach the manuscript as a Microsoft Word document or plain text file. Photos, tables, and figures can be embedded in the document, although submission of individual files is preferred. Figures not embedded in the main Word document should be submitted as .jpg files.

Please send queries and submissions to: Janice@lermagazine.com

We look forward to hearing from you!



MS MORE PREVALENT AMONG BLACK AMERICANS THAN ONCE THOUGHT

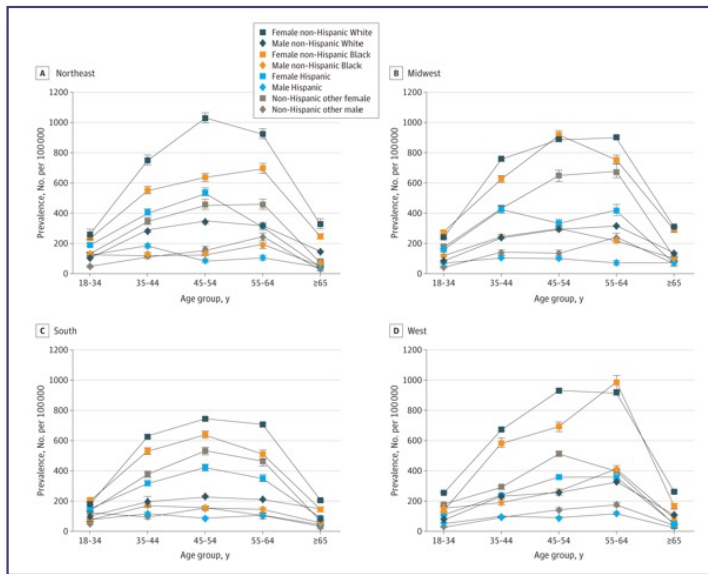


Figure. 2010 Prevalence of Multiple Sclerosis per 100,000 Adults Cumulated Over 10 Years in the United States by Age, Sex, Race, Ethnicity, and US Geographic Census Region: Northeast (Region 1), Midwest (Region 2), South (Region 3), and West (Region 4)

According to a new study¹ by researchers at the University of Maryland School of Medicine, multiple sclerosis (MS) is more prevalent – particularly among Black Americans – than previously thought. Using de-identified health insurance claims of 96 million adults living in the United States, the research team was able to estimate in more detail how many individuals age 18 and older are living with MS and the prevalence rates among people of different races or ethnicities living in specific regions. (Figure)

The study found strong evidence of a higher prevalence of MS across the northern regions of the US compared to southern regions, potentially related to the spread of viruses in colder climates where people remain indoors more or lower vitamin D levels from less sun exposure.

While several studies² have linked low vitamin D levels with increased risk of MS, a recently released study³ found that the common Epstein-Barr virus infection greatly increased the risk for developing MS by demonstrating that antibodies made by the body against the virus attack a vital protein in the brain and spinal cord.

In terms of prevalence among sub-groups, MS occurs in about 4 in 1,000 white people, about 3 in 1,000 Black people, about 2 in 1,000 people of “other races” including Asians, Native Americans, Alaska natives and multi-race individuals, and about 1.5 in 1,000 people of Hispanic/Latinx origin. ^{ler}

Sources: 1. Hittle M, Culpepper WJ, Langer-Gould A, et al. Population-based estimates for the prevalence of multiple sclerosis in the United States by race, ethnicity, age, sex, and geographic region. *JAMA Neurol.* 2023;80(7):693–701. doi:10.1001/jamaneurol.2023.1135.

2. Sintzel MB, Rametta M, Reder AT. Vitamin D and multiple sclerosis: a comprehensive review. *Neurol Ther.* 2018;7(1):59-85. doi: 10.1007/s40120-017-0086-4.

3. Thomas OG, Bronge M, Tenvall K, et al. Cross-reactive EBNA1 immunity targets alpha-crystallin B and is associated with multiple sclerosis. *Sci Adv.* 2023 May 19;9(20):eadg3032. doi: 10.1126/sciadv.adg3032.

VIBRATION AIDS HARD-TO-HEAL WOUNDS



A new scoping review from Japan suggests that low-frequency and low-intensity vibration therapies helped effectively treat wounds (including pressure injuries, diabetic foot ulcers, and venous leg ulcers) by improving blood flow, relieving pain, reducing exudate, removing necrotic tissue, and increasing the expression of nitric oxide associated with wound healing. ^{ler}

Source: Haba D, Itabashi M, Tamai N, Tobe H, Sanada H, Nakagami G. Effectiveness of vibration therapy for hard-to-heal wounds in clinical study: a scoping review. *Chron Wound Care Mgmt Res.* 2024;11:1-12. <https://doi.org/10.2147/CWCMR.S423054>

EXERCISE + ELECTRICAL SIMULATION FOR CAI

Chronic ankle instability (CAI) is diagnosed when symptoms (perceptions of the ankle ‘giving way’, pain, weakness, or limited ankle range of

motion) have persisted for more than 1 year after an initial lateral ankle sprain. Therapeutic exercise is a key treatment for overcoming neuromuscular deficits in CAI. In this study, researchers from Israel's Ariel University wanted to compare the short, medium, and long-term effects of balance exercises combined with either peroneal neuromuscular electrical stimulation (NMES) or peroneal transcutaneous electrical nerve stimulation (TENS) on dynamic postural control and patient reported outcome measures (PROMs) in patients with CAI. They hypothesized that due to the potential effects on muscle strength and augmented sensory feedback of muscle contraction associated with NMES, greater improvement would be observed in this group versus a group using TENS.


They randomly assigned 34 participants with CAI to a 12-session home based exercise program combined with NMES (Ex-NMES) or TENS (Ex-TENS). Baseline postural control was tested with the modified Star Excursion Balance Test (mSEBT) and time to stabilization (TTS) after a single-leg drop-jump. The self-reported function was measured using the Cumberland Ankle Instability Tool (CAIT), the Identification of Functional Ankle Instability (IdFAI), and the Sports subscale of the Foot and Ankle Ability Measure (FAAM).

The results showed significant improvements in both groups in all self-reported outcome measures at the 12-month follow-up. Subjects in the Ex-NMES group had significantly better IdFAI (-4.2 [95% CI -8.1, -0.2]) and FAAM (13.7 [95% CI 2.2,25.2]) scores at 6- and 12-month follow-up, respectively, compared to the Ex-TENS group. Medium to large between-group effect sizes were observed in self-reported functional



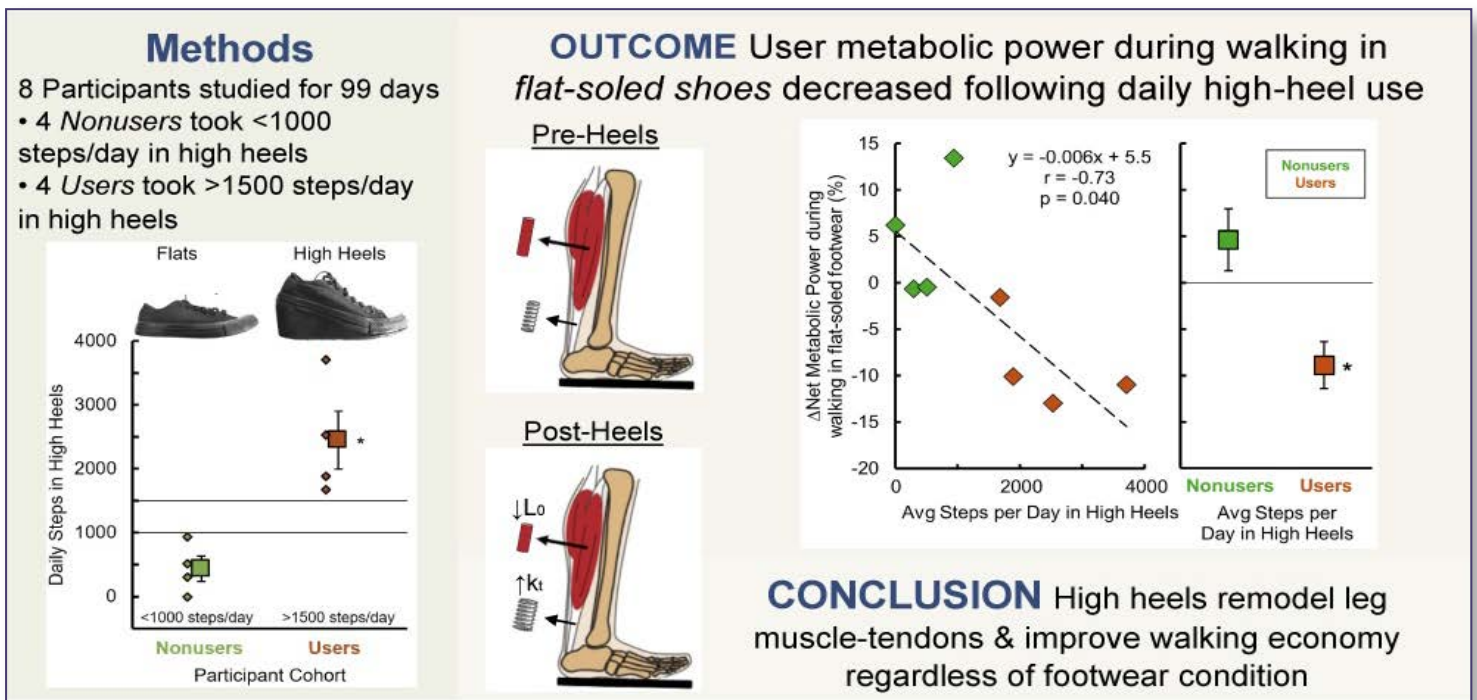
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outcomes and the mSEBT.

While noting that their results do not allow for a definitive conclusion, the authors observed a consistent trend of improvement in self-reported functional outcomes when training is combined with NMES compared with training with TENS may indicate a potential benefit for reducing disability in this patient population. 

Source: Gottlieb U, Hayek R, Hoffman JR, Springer S. Exercise combined with electrical stimulation for the treatment of chronic ankle instability - a randomized controlled trial. *J Electromyogr Kinesiol.* 2024;74:102856. doi: 10.1016/j.jelekin.2023.102856. Used with permission.

HIGH HEELS REMODEL LEG MUSCLES



Source: Beck ON, Schroeder JN, Sawicki GS. Habitually wearing high heels may improve user walking economy in any footwear. *J Appl Physiol* (1985). 2024;136(3):567-572. doi: 10.1152/jappphysiol.00016.2024.

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THERAPEUTIC BENEFITS OF TAI CHI HIGHLIGHTED

The inaugural meeting of the Tai Chi & Qigong as Whole Person Health Conference was held in Boston, MA, in September 2023. It was hosted by the Osher Center for Integrative Medicine and jointly sponsored by the Harvard Medical School and Brigham and Women's Hospital. Nearly 300 experts, professors, researchers, and professionals from 12 countries participated in this international gathering dedicated to the science of Tai Chi and Qigong. Select findings relevant to LER readers are listed below.

- Long-term Tai Chi (TC) training is associated with higher levels of **physical function** in older adults, suggesting a potential preventive healthy aging effect. One example: in a study comparing 60 TC experts vs 27 TC naïves, values for single leg stance time with eyes closed (SLST-EC) were $15.1 \pm 2.2s$ vs $6.6 \pm 2.1s$ ($p < 0.001$). *Ma Y, et al. Can Tai Chi Make Older Adults 'Functionally Younger? OA01.02.*
- Tai Chi plus usual care may improve health outcomes in patients with **chronic heart failure**. In particular, when compared to other exercise plus usual care, this meta-analysis found that tai chi plus usual care showed a significant benefit in the 6-min walk test (6MWT; 29.25 m, $p < 0.0001$). *Cai Y, et al. Effects of Tai Chi Plus Usual Care for Chronic Heart Failure: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. OA02.04.*
- **Peripheral neuropathy** (PN) increases patients' risk of falling as it impairs balance and sensory function. In a scoping review of 54 studies, 8 consistently demonstrated that TC improved participant balance as measured with the 1-leg standing test, Activities-Specific Balance Confidence scale, and Functional Reach Test. Participants also demonstrated increased sensory function as measured with the sway balance test, plantar sensory threshold, and nerve conduction. *Yang M, et al. Effects of Tai Chi Plus Usual Care for Chronic Heart Failure: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. OA02.04.*
- Nearly 50% of veterans experience **chronic pain**, particularly those who suffer with Gulf War Illness (GWI). In this study, 70 vets participated in 1-hr TC classes twice/wk for 12 wks. GW Vets in the TC program exhibited significant increases in the average number of hours spent on stretching from baseline to the post-treatment ($p < .001$), 3 months ($p = .002$), and 9 months ($p = .02$). Feedback interviews showed that Vets



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appreciated TC, enjoyed the stretching components, and reported feeling increased flexibility and mobility. *Busser C, et al. Tai Chi Intervention for Stretching and Flexibility in Gulf War Veterans. P02.16.*

- Turo is a hybrid TC/qigong dancing program developed to relieve motor dysfunction symptoms in Parkinson's Disease (PD) patients. This qualitative study included 7 patients who agreed to the 1-hour program, twice/week for 8 weeks. Measure Yourself Medical Outcome Profiles (MYMOP) results showed a significant increase in Well-being, Main symptoms 1 and 2, and Activeness. MYMOPs are individualized health outcome questionnaires created by participants to address their individual concerns. *Lee H-J, et al. The Experience of the Turo (Qi dance) Program for Patients with Parkinson's Disease: A Qualitative Study. P02.17.*
- Three clinical practice guidelines for **knee osteoarthritis** (KOA) now include recommendations for Tai Chi as appropriate therapy. TC addresses the root causes of KOA by improving the biomechanical forces on the knee and decreasing inflammation, thus allowing normal healing and repair processes to resume. *Huston P. How Tai Chi May Influence Cell Behaviour in Osteoarthritis of the Knee. P01.01.*
- A 12-week **aquatic Tai Chi** exercise could significantly improve college students' subjective and objective sleep quality. *Wan X, et al. Aquatic Tai Chi's Effect on Sleep Quality Improvement in College Students. P05.03. (ler)*

Source: *Journal of Integrative and Complementary Medicine.* 2023;29(S2). Available at <https://www.liebertpub.com/doi/10.1089/jicm.2023.29125.abstracts>.

Association of Knee and Hip OA with Fall Risk and Fractures

BY YOUYOU ZHANG, XIAOXI LI, YINING WANG, LIRU GE, FAMING PAN, TANIA WINZENBERG, AND GUOQI CAI

Patients with knee and hip OA frequently have pain, muscle weakness, impaired joint proprioception, and poor balance, which are important risk factors for falls.

Falls and osteoarthritis (OA) are major public health problems. The incidence of falls and fractures increases with age, and knee OA and hip OA are also highly prevalent in older populations. Nearly 30% of individuals older than 45 years have radiographic evidence of knee OA, and about half have knee symptoms. Patients with knee and hip OA frequently have pain, muscle weakness, impaired joint proprioception, and poor balance, which are important risk factors for falls. Studies evaluating the association of knee and hip OA with falls and fractures have inconsistent findings. The aim of this systematic review and meta-analysis was to investigate associations of symptomatic and radiographic knee and hip OA with risk of falls, recurrent falls, and fractures.

Methods

An electronic search of databases from inception to February 2023 was conducted. Two authors independently screened studies, extracted data, and assessed the risk of bias using the Newcastle-Ottawa Scale tool in eligible studies. Pooled odds ratios (ORs) with 95% confidence intervals (CIs) were calculated using random-effects models.



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Results

Of 17 studies included ($n = 862,849$), 2 had a high risk of bias. Among studies that evaluated falls or fractures as outcomes, 7/8 (87.5%) and 5/11 (45.5%) were self-reported, respectively. Both symptomatic knee and hip OA were associated with increased risk of recurrent falls (knee: OR = 1.55, 95% CI 1.10 to 2.18; hip: OR = 1.50, 95% CI 1.28 to 1.75) but not falls or fractures. Radiographic knee OA increased risk of falls (OR = 1.28, 95% CI 1.03 to 1.59) but did not significantly increase risk of recurrent falls (OR = 1.39, 95% CI 0.97 to 1.97) or fractures (OR = 1.22, 95% CI 0.99 to 1.52). Radiographic hip OA decreased the risk of recurrent falls (OR = 0.70, 95% CI 0.51 to 0.96) but had no

statistically significant association with fractures (OR = 1.16, 95% CI 0.79 to 1.71).

Discussion

The results of this meta-analysis revealed that symptomatic knee and hip OA were associated with an increased risk of recurrent falls, but were not associated with the risk of fractures. Radiographic knee OA was associated with an increased risk of falls. While the quality of evidence of included studies was moderate to very low, symptomatic knee and hip OA should be considered as potential risk factors for falls and falls risk assessment, and preventive interventions in people with OA at these sites considered.

While only radiographic knee OA was

This article has been excerpted from "Association of knee and hip osteoarthritis with the risk of falls and fractures: a systematic review and meta-analysis." *Arthritis Res Ther.* 2023;25:184. <https://doi.org/10.1186/s13075-023-03179-4>. Editing has occurred, including the renumbering or removal of tables and/or figures, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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associated with an increased risk of falls, both symptomatic and radiographic knee OA showed a similar magnitude in the increased risk of recurrent falls, though for radiographic knee OA this was not statistically significant. This is likely to reflect a real effect of knee OA on falls because a single fall may be coincidental, whereas recurrent falls are more likely to have an internal, disease-related cause, and they generally lead to more serious consequences. Considering the high prevalence of knee OA and the severity of falls in older adults, it is important to strengthen medical care and develop preventive interventions to reduce falls in this population. In patients with knee and hip OA, routine use of screening tools may help to identify those at increased risks of falls and fractures, and this is likely to promote the implementation of primary preventions, such as self-management, home safety resources, and more intensive clinical care. Exercise programs have also been shown to strengthen the muscles of the lower limb and improve balance, and thus reduce the risk of falls and the fear of falling in people with OA, and could be considered for people with knee and hip OA. However, OA patients are different from the general population in many aspects, such as joint stability, balance, muscle strength, and bone quality; therefore, more research is needed to evaluate whether OA-specific screening tools could provide a more precise estimation for falls and fractures.

There were no statistically significant associations between symptomatic knee or hip OA and the risk of any fractures, including vertebral fractures. However, a recent study found that the associations of bilateral knee symptoms with the risk of fractures were attenuated and no longer statistically significant after further adjusting for falls. This finding is consistent with the study's sensitivity analysis showing that symptomatic knee OA was associated with an increased risk of fractures. Thus, the potential role of knee OA in fractures cannot be ruled out.


While symptomatic hip OA was associated with an increased risk of recurrent falls, radiographic hip OA was associated with a decreased risk. It remains unclear whether sex

OA patients are different from the general population in many aspects, such as joint stability, balance, muscle strength, and bone quality

has a modification effect on the association between OA and fracture risk. In a post-hoc study of a randomized controlled trial, women with knee pain or clinician-diagnosed knee OA were found to have a higher risk of fractures, but it is unknown whether the association between knee OA and fracture risk was stronger in women. In a recent study by the authors using data from the Osteoarthritis Initiative, however, they found that men with unilateral knee symptoms had a higher risk of fractures than women. Therefore, the role of sex in the association between OA and fracture risk needs further study.

A recent meta-analysis evaluated the association of knee and hip OA with the risk of falls and found that knee but not hip OA was positively associated with the risk of falls (RR: 1.46; $P < 0.01$), and that radiographic OA (knee and hip OA combined) was not significantly associated with fall risk ($P > 0.05$). This pooling of OA sites and of both symptomatic and radiological OA may be problematic given there are significant differences between knee and hip OA. Indeed, when the study authors updated the literature search and separated symptomatic and radiographic OA for both the knee and the hip, they found that while symptomatic knee and hip OA were both associated with an increased risk of recurrent falls (OR = 1.28, $P < 0.05$), radiographic knee OA was associated with an increased and radiographic hip OA with a decreased risk of falls (OR = 0.70, $P < 0.05$). More studies are needed in the future to examine these findings.

Conclusion

Symptomatic knee and hip OA were both associated with an increased risk of recurrent falls, and radiographic knee OA was associated with an increased risk of falls. No statistically significant associations of radiographic and symptomatic knee or hip OA with fractures were found. Symptomatic knee and hip should be considered as potential risk factors for falls and falls risk assessment and preventive interventions in people with OA at these sites considered. 

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Treadmill-related Lower Extremity Injuries Treated at United States Emergency Departments

BY MATHIAS B. FORRESTER, BS

Background: Treadmills are the most popular piece of exercise equipment, with millions of people in the United States (US) using the devices each year. Thousands of people are treated for treadmill-related injuries in the US annually. The objective of this study was to describe treadmill-related lower extremity injuries treated at US hospital emergency departments (EDs).

Methods: Treadmill-related lower extremity injuries during 2000-2022 were identified using the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries treated at a representative sample of US hospital EDs. Cases reported to the NEISS can be used to calculate national injury estimates. The distribution of treadmill-related lower extremity injuries was determined for patient demographics, injury circumstances, and management.

Results: Of an estimated 451,250 total treadmill-related injuries, 153,551 (34.0%) involved the lower extremity. Of these lower extremity injuries, the affected body part was 30.8% knee, 20.5% foot, 17.6% ankle, 16.0% lower leg, 10.1% toe, and 5.0% upper leg. The injuries were 36.8% strain or sprain, 17.8% contusion or abrasion, 9.5% fracture, 6.4% laceration, 1.7% dislocation, 1.5% avulsion, and 26.3% other/not stated. The age distribution was 4.3% 0-5 years, 9.9% 6-12 years, 7.5% 13-19 years, 13.3% 20-29 years, 15.7% 30-39 years, 16.5% 40-49 years, 13.7% 50-59 years, 9.3% 60-69 years, 6.4% 70-79 years, and 3.5% 80 years or older; 62.2% of the patients were female and 37.8% male.

Conclusion: One-third of all treadmill-related injuries treated at US hospital EDs involved the lower extremity. The highest proportion of patients with lower extremity injuries were aged 30-49 years, and most patients were female. The most commonly reported injuries were strain or sprain, contusion or abrasion, and fracture, and the most frequently affected parts of the lower extremity were the knee, foot, and ankle.



A treadmill is an exercise machine mainly used for running, walking, or climbing while remaining in one place. The device is a moving platform with a conveyor belt driven by an electric motor or flywheel. The conveyor belt moves backward, forcing the person on the belt to run or walk at a speed matching the belt. Depending on the type of treadmill, the speed, inclination, and other factors may be adjusted. Treadmills may be found in such locations as healthcare facilities (eg, hospitals, rehabilitation centers), fitness facilities, and homes. Treadmills also may be found in the workplace as treadmill desks.¹

Treadmills are the biggest-selling exercise equipment category.¹ One analysis reported approximately 50 million people in the United States (US) aged 6 years or older used treadmills annually.² According to the International Health, Racquet and Sportsclub Association (IHRSA) 2018 IHRSA Health Club Consumer Report, during the previous 3 years, treadmills were the most popular piece of exercise equip-

ment, with 43% of members using the devices.³

Treadmills account for a large proportion of exercise-related injuries. A study of home mechanical exercise equipment-related injuries treated at hospital emergency departments (EDs) reported that 66% of the injuries involved treadmills.⁴ Another study found that treadmills accounted for 25% of all home exercise equipment injuries involving children ages 18 years and younger treated at hospital EDs.⁴

Thousands of people are treated for treadmill-related injuries in US EDs each year.^{5,6} Treadmill-related injuries include soft tissue injuries (contusions, abrasions, crushing injuries, and hematomas), strains and sprains, lacerations, fractures, friction burns, and blunt trauma.^{5,7} Deaths have been associated with treadmills.⁶

Several studies have indicated that over one-third of treadmill-related injuries involved the lower extremity.^{7,8} The objective of this study was to describe treadmill-related lower extremity injuries reported to US hospital EDs.

Continued on page 18

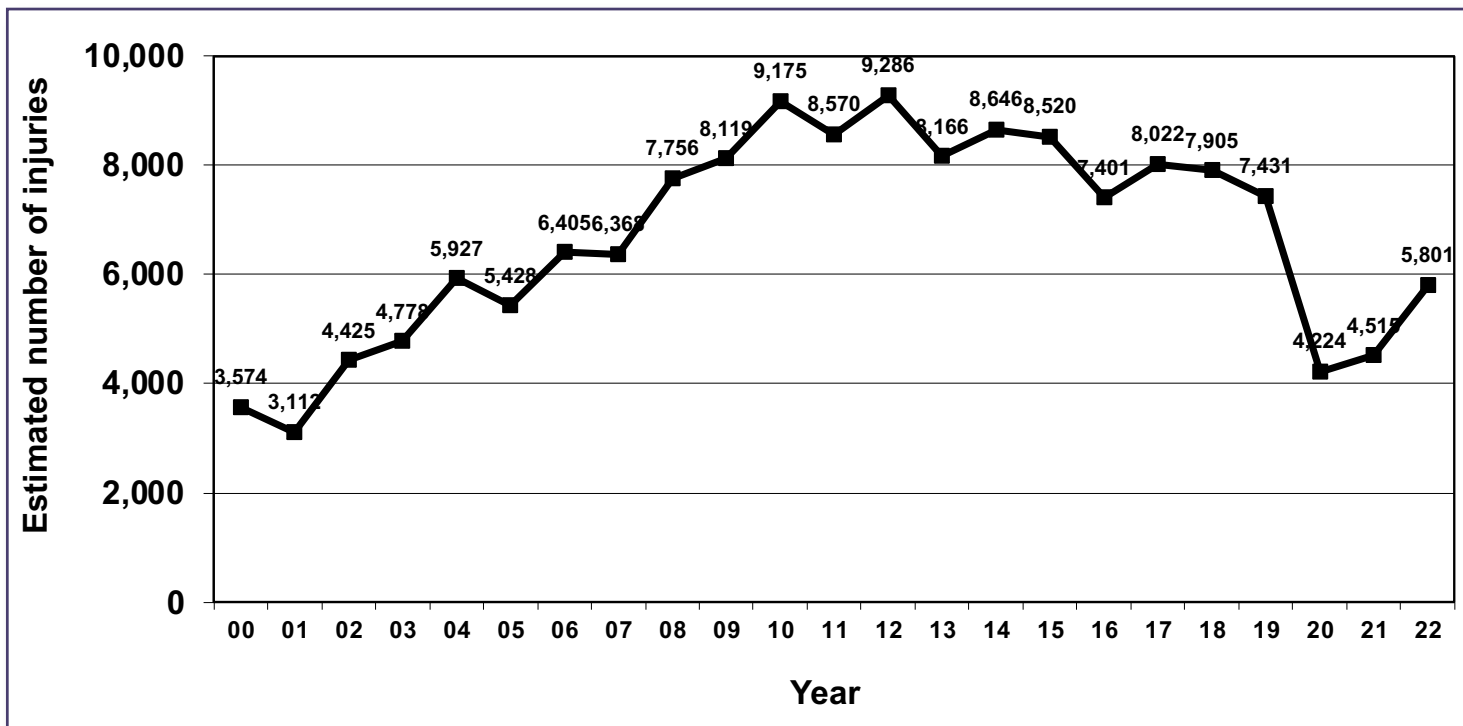


Figure 1: Annual estimated number of treadmill-related lower extremity injuries reported to the National Electronic Injury Surveillance System, 2000-2022

Methods

Data were obtained from the National Electronic Injury Surveillance System (NEISS) website (<https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx>). The NEISS database has been described in detail in Lower Extremity Review previously.^{9,10} Briefly, the NEISS is a database of consumer product-related injuries collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample.^{11,12} Data are publicly available and de-identified; thus, the study is exempt from institutional review board approval.

Cases were treadmill-related lower extremity injuries reported to the NEISS database during 2000-2022. The publicly available NEISS database contains three numeric fields for coding the product involved in the injury (Product_1, Product_2, Product_3). Treadmills are usually assigned product code 3277 (exercise equipment). However, this product code is not specific to treadmills but also may be used for other types of exercise equipment.

The NEISS database contains a text field (field name Narrative) that provides a brief summary of the circumstances of the injury. The NEISS database was searched for all records that included the letter groups “tre” and “mil” in the Narrative field. The Narrative fields of the resulting records were individually examined, and any records that involved a treadmill-related injury were included in the study. That the injury involved a lower extremity was based on the Body_Part numeric field (a field that documents the injured body part) containing codes for a lower extremity (upper leg, knee, lower leg, ankle, foot, toe). The NEISS database contains another numeric field for documenting whether a second body part was injured (Body_Part_2); however, this field was only added in 2018,¹²

although this field does not appear to have been used until 2019. For consistency over the entire study period, the Body_Part field alone was examined. (Fifty-four cases had a lower extremity coded in the Body_Part_2 field but not in the Body_Part field during 2019-2022.)

The variables examined were treatment year; patient age, sex, and race; location where the incident occurred; type of injury (diagnosis); affected body part; and disposition. Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). For all treadmill-related lower extremity injuries, the distribution of cases and national injury estimates were determined for the variables. National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database, and 95% confidence intervals (CIs) were calculated for the estimates. The CPSC considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.¹¹ For those variable subgroups where the estimate was <1,200, 95% CIs were not calculated.

During 2000-2022,
3,945 treadmill-related
lower extremity injuries
were treated at a sample
of US hospital EDs

Results

Table 1. Affected body part and diagnosis of treadmill-related lower extremity injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Body part affected					
Knee	1,179	29.9	47,343	30.8	38,111-56,574
Foot	819	20.8	31,477	20.5	24,873-38,080
Ankle	708	17.9	27,071	17.6	21,228-32,914
Lower leg	634	16.1	24,495	16.0	19,105-29,885
Toe	416	10.5	15,547	10.1	11,793-19,301
Upper leg	189	4.8	7,618	5.0	5,448-9,789
Type of injury					
Strain or sprain	1,389	35.2	56,440	36.8	45,759-67,121
Contusion or abrasion	765	19.4	27,302	17.8	21,419-33,186
Fracture	391	9.9	14,640	9.5	11,059-18,220
Laceration	273	6.9	9,850	6.4	7,214-12,485
Dislocation	57	1.4	2,627	1.7	1,603-3,650
Avulsion	50	1.3	2,377	1.5	1,417-3,336
Other/not stated	1,020	25.9	40,316	26.3	32,230-48,401
Total	3,945		153,551		128,668-178,433

No. = Number

Est. = Weighted estimate (sum of the Weight numeric field in the National Electronic Injury Surveillance System database). The numbers in the Weight field are not whole numbers but include decimals. As a result of rounding to whole numbers when performing analyses, the sum of the estimates for a given variable might not equal the total. The Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.

95% CI = 95% confidence interval. Not calculated if the estimate is <1,200.

During 2000-2022, 3,945 treadmill-related lower extremity injuries were treated at a sample of US hospital EDs, resulting in a national estimate of 153,551 (95% CI 128,668-178,433) treadmill-related lower extremity injuries. This represents 34.0% of the 451,250 total estimated treadmill-related injuries affecting any body

part. The knee was the most frequently affected part of the lower extremity, followed by the foot and ankle (Table 1). The most common types of injury were strain or sprain, contusion or abrasion, and fracture (Table 1).

The annual estimated number of treadmill-related lower extremity injuries increased

from 2000 to a peak in 2012 before declining to 2020 before increasing once more (Figure 1). The estimated number of injuries declined from 7,431 in 2019 to 4,224 in 2020, a 43% decrease.

Table 2 shows the patient demographics of treadmill-related lower extremity injuries. The highest proportions of patients were aged 30-39

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Table 2. Patient demographics of treadmill-related lower extremity injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Patient age (years)					
0-15	250	6.3	6,624	4.3	4,667-8,580
6-12	472	12.0	15,147	9.9	11,469-18,824
13-19	332	8.4	11,496	7.5	8,529-14,464
20-29	546	13.8	20,347	13.3	15,702-24,993
30-39	586	14.9	24,095	15.7	18,776-29,414
40-49	583	14.8	25,344	16.5	19,804-30,884
50-59	519	13.2	21,037	13.7	16,267-25,808
60-69	334	8.5	14,270	9.3	10,760-17,780
70-79	217	5.5	9,762	6.4	7,145-12,380
80+	106	2.7	5,428	3.5	3,737-7,120
Patient sex					
Female	2,353	59.6	95,463	62.2	78,860-112,065
Male	1,592	40.4	58,088	37.8	47,148-69,028
Race					
White	1,703	43.2	76,101	49.6	62,386-89,815
Black/African America	651	16.5	20,551	13.4	15,869-25,234
Asian	36	0.9	1,245	0.8	591-1,899
American Indian/Alaska Native	10	0.3	324	0.2	-
Native Hawaiian/Pacific Islander	2	0.1	111	0.1	-
Other	232	5.9	7,981	5.2	5,734-10,229
Not stated	1,311	33.2	47,237	30.8	38,023-56,452
Total	3,945		153,551		128,668-178,433

Please see full footnote on Table 1.

years and 40-49 years; these two age groups accounted for approximately 30% of the injuries. The majority of patients were female, and most patients were White.

Table 3 provides the distribution of injuries by location of the incident and patient disposition. Of those injuries where the location of the incident was known, the majority occurred at home followed by a place of recreation or sports. Of the 15,003 estimated injuries among patients aged 0-12 years where the location of the incident was known, 13,343 (88.9%) occurred at home and 866 (5.8%) occurred at a place of recreation or sports. Of the 72,098 estimated injuries among patients aged 13 years and older where the location of the incident was known, 42,154 (58.5%) occurred at home and 23,759 (33.0%) occurred at a place of recreation or sports. Most of the patients were treated or evaluated at the ED and released.

Discussion

This study examined treadmill-related lower extremity injuries treated at US hospital EDs. This information is important because treadmills are the most popular piece of exercise equipment, with millions of people in the US using the devices each year. Thousands of people are treated for treadmill-related injuries in the US annually. Several prior studies have indicated that over one-third of treadmill-related injuries involve the lower extremity.^{7,8} The current study was consistent with this literature in that it found that 34% of total estimated treadmill-related injuries involved the lower extremity.

Thirty percent of the lower extremity injuries involved the knee with the next most frequently injured body parts being the foot and ankle. The most common types of injury were strain or sprain, contusion or abrasion, and fracture. These injuries usually are not expected to require extensive medical intervention. This is consistent with the finding that 97% of the patients with treadmill-related lower extremity injuries were treated or examined and released from the ED.

The annual number of treadmill-related lower extremity injuries increased from 2000 to

One analysis reported approximately 50 million people in the United States (US) aged 6 years or older used treadmills annually.

2012 then decreased to 2020 before increasing over the next 2 years. The decline in annual injuries after 2012 may reflect a decline in the use of treadmills by the US population, occurrence of treadmill-related injuries, or seeking treatment of these injuries at hospital EDs. Alternately, it may be that the people documenting injuries for NEISS became less likely to mention a treadmill in the record Narrative field.

Of note was the 43% decline in the estimated number of treadmill-related lower extremity injuries between 2019 and 2020. This was the greatest year-on-year percent change in the number of injuries during the study period, the next closest being a 42% increase between 2001 and 2002. Even though the estimated annual number of injuries increased in 2021 and 2022, it was still lower than any year since 2005. The low estimated number of treadmill-related injuries of the lower extremity during 2020-2022 is likely due to the COVID-19 pandemic. A study that examined the effect of the COVID-19 pandemic on sports-related injuries found that injuries sustained while participating in personal fitness activities decreased by 18% in 2020. This decline was attributed to recommendations that minor injuries be treated at home and the general fear of contracting COVID-19 during a hospital visit.¹³

Patients aged 30-49 years accounted for the 30% of all treadmill-related injuries of the lower extremity, and most of the patients were female. People aged 30-39 years and females may be more likely to use treadmills or more likely to experience injuries that are treated at

hospital EDs.

Of those treadmill-related injuries of the lower extremity with a known location of the incident, most occurred at home with the next most common location being a place of recreation or sports. However, this pattern was influenced by patient age. Of those injuries with a known location of the incident, for patients aged 0-12 years, 89% of the injuries occurred at home and 6% occurred at a place of recreation or sports while, for patients aged 13 years and older, 58% of the injuries occurred at home and 33% occurred at a place of recreation or sports. This might be expected because young children are less likely to be present or permitted to use mechanical exercise equipment at places of recreation or sports. But no matter what the patient age, the majority of injuries occurred at home. This suggests that activities to reduce or prevent treadmill-related injuries should focus on the home.

There are ways to reduce the risk of treadmill-related injuries. It has been recommended that people pay attention while using a treadmill, accelerate and decelerate slowly, and keep young children away from the treadmill.⁵

There are limitations to this study. Treadmill-related injury cases were initially identified by selecting those records with the letter groups “tre” and “mil” in the Narrative field. If these letter combinations were not used in instances of treadmill-related injuries, then these cases would not have been included in the study. In addition, temporal changes in treadmill-related injuries may reflect changes in the documentation of treadmills in the Narrative field over time. Furthermore, details, such as whether the injury occurred to a person actively using the treadmill or someone, such as a child, having incidental contact with the treadmill, were not examined. The study only included injuries treated at hospital EDs. Information on injuries treated elsewhere might provide a more complete perspective of treadmill-related injuries.


In conclusion, one-third of all treadmill-related injuries treated at US hospital EDs involved the lower extremity. The highest proportion of patients with lower extremity injuries

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Table 3. Location of incident and disposition of treadmill-related lower extremity injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Location of incident					
Home	1,353	34.3	55,497	36.1	44,965-66,030
Place of recreation or sports	681	17.3	24,624	16.0	19,211-30,037
Other public property	136	3.4	5,802	3.8	4,027-7,577
School	24	0.6	1,115	0.7	-
Street or highway	4	0.1	62	0.0	-
Not recorded	1,747	44.3	66,450	43.3	54,210-78,691
Disposition					
Treated or examined and released	3,823	96.9	149,295	97.2	125,004-173,586
Treated and transferred to another hospital	3	0.1	96	0.1	-
Treated and admitted for Hospitalization	76	1.9	2,528	1.6	1,530-3,526
Held for observation	5	0.1	129	0.1	-
Left without being seen/against medical advice	37	0.9	1,486	1.0	765-2,208
Not recorded	1	0.0	16	0.0	-
Total	3,945		153,551		128,668-178,433

Please see full footnote on Table 1.

were aged 30-49 years, and most patients were female. The most commonly reported injuries were strain or sprain, contusion or abrasion, and fracture, and the most frequently affected parts of the lower extremity were the knee, foot, and ankle. Most of the patients were treated or evaluated at the ED and released. 

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Strategies to Treat DFUs Complicated by Edema

BY JUSTINE TANSLEY, MRCPOD; RICHARD COLLINGS, PHD, DSC (HONS); JENNIFER WILLIAMS, BSC (HONS); AND JOANNE PATON, PHD, MSC

The management of DFUs complicated by the effects of lower limb edema is clinically challenging, and both conditions can require a multifaceted treatment approach.

Lower limb edema is a common comorbidity in those with diabetes and foot ulceration and is linked with increased amputation risk. There is no current guidance for the treatment of concurrent diabetic foot ulcers (DFUs) and lower limb edema, leading to uncertainty around the safety and efficacy of combination approaches incorporating offloading and compression therapies. To determine indications and contraindications for such strategies and identify any other supplementary treatment approaches, a scoping review was undertaken to map the evidence relating to offloading and compression therapy strategies to treat both DFU and lower limb edema in combination.

Methods

Following the Joanna Briggs Institute (JBI) and PRISMA—Scoping Review (ScR) guidance, this review included published and unpublished literature from inception to April 2022. Literature was sourced using electronic databases including Cochrane Library, PubMed, CINAHL, AMED; websites; professional journals, and reference lists of included literature. Eligible literature discussed the management of both



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DFUs and lower limb edema and included at least 1 of the treatment strategies of interest. Data extraction involved recording any suggested offloading, compression therapy, or supplementary treatment strategies and any suggested indications, contraindications and cautions for their use.

Results

Five hundred twenty-two publications were found relating to the management of DFUs with an offloading strategy or the management of lower limb edema with compression therapy, of which 51 were eligible for inclusion in the review. The majority of the excluded publications did not discuss the situation where DFUs and lower limb edema present concurrently.

Discussion

A scoping review was carried out which aimed to establish what available offloading and compression therapy strategies exist to manage a DFU complicated by the effects of lower limb edema

Offloading strategies

International guidance recommends that a non-removable knee-high cast, such as a total contact cast (TCC), is used as a first-line treatment to offload a DFU, unless contraindicated. This scoping review found 1 retrospective cohort study suggesting that lower limb edema may be 1 of these contraindications. The study suggests that a TCC is not suitable for those with a DFU and lower limb edema as an increased number of adverse events was reported in this

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population. It was agreed that such devices were primarily intended to assist with DFU healing, yet there were opposing arguments about their use in the presence of edema and associated complications. Definitive direction regarding the indications and contraindications for the use of a TCC in these circumstances was lacking from the evidence.

Current guidance also recommends that a knee-high walking cast may be used as a second-line alternative if a non-removable TCC is not tolerated. Some of the literature suggests that a removable knee-high walking cast should accommodate lower limb edema for limb protection, yet other literature supports the use of a removable pneumatic walker cast, to offload a foot wound and reduce edema. Neither suggestion was supported by scientific studies or other forms of evidence. There was a lack of information regarding the use of knee-high removable casts/walkers to treat a DFU where lower limb edema was present and no discussion was found concerning appropriate use or contraindications in these circumstances.

An ankle-high removable cast is a third-line recommendation, if a knee-high cast is not tolerated or contraindicated. The International Working Group for the Diabetic Foot acknowledges this recommendation in its guidance is not supported by high-quality evidence. The literature found by the review, suggests that an ankle-high design is intended to allow for treatment of a leg condition, yet it is difficult to make a definite conclusion as to the suitability of this strategy to treat a DFU in the presence of lower limb edema. No scientific studies were found demonstrating that these offloading devices could be safely and effectively used in combination with a leg treatment such as compression therapy.

Two further strategies were found that are not included in any current guidance: The use of a back-slab style cast to offload a DFU and accommodate any fluctuations in lower limb edema; and a heel offloading device designed to relieve pressure from a heel wound when a person is lying prone, which may accommodate leg swelling but it is not suitable if leg wounds or exudate are present. Both strategies were not

supported by scientific studies or other forms of high-level evidence.

Compression therapy strategies

Although there is no current guidance for the use of compression therapy to manage lower limb edema in the presence of a DFU, benefits for its use are acknowledged in the literature. This scoping review found that full-strength multi-layer bandaging may be used in those without arterial compromise; reduced-strength bandaging may be used in those with reduced arterial blood supply; and a wound was unlikely to heal if there was severe arterial compromise as compression is likely to further reduce blood flow. Several case studies were found all sharing successful practice where DFU management was complicated by lower limb edema. All of the case studies introduced compression bandaging to promote wound healing. However, reports of failed or ineffective cases and their circumstances were not found, leaving unanswered questions about the true safety and effectiveness of compression bandaging in these circumstances.

This review found literature which suggests that compression hosiery could be a useful way to manage lower limb edema where a DFU is present. Two used participants with diabetes, with or without mild to moderate peripheral arterial disease (PAD), to test the safety of compression hosiery. Both studies reported that there was no effect on arterial blood supply when hosiery was worn and after removal. Participants with large wounds, copious amounts of exudate, and infection were excluded, which suggests this strategy may not be appropriate for those with more severe complex wounds.


This review found literature that suggests the use of pneumatic compression to manage lower limb edema where a DFU was also present. Wound healing and prevention of major amputation were the main outcomes of interest. The majority of the literature agreed that pneumatic compression could be used to promote healing in wounds of any etiology, including in those with severe PAD where re-vascularization is not possible. However, the literature acknowl-

edges the supporting evidence to be of low methodological quality.

Supplementary strategies

This scoping review found 16 supplementary strategies to manage a DFU and lower limb edema where both conditions present together: integrated working, leg elevation, patient-specific care plan, dermal replacement allograft, elbow crutches, exercise (non-specific), Theraband, manual lymphatic drainage, weight control, wound scoring tools, bed rest, general skin care, neuromuscular taping, patient education, pharmacological, and surgical. Integrated working, patient-specific treatment plans, and the use of wound and leg assessment tools were popular in expert opinion. The rationale for these 3 strategies was they could be applied to any clinical situation including where complex comorbidities exist that impact the lower limb, used to improve the quality of treatment planning and subsequent care and outcomes. However, all of the supplementary strategies found by this scoping review, lacked a scientific basis to support their use in a combination management approach of a DFU and lower limb edema.

Conclusions

Most literature focused on edema management with compression therapy to conclude that compression therapy should be avoided in the presence of severe PAD. Less literature was found regarding offloading strategies, but it was recommended that knee-high devices should be used with caution when offloading DFUs in those with lower limb edema. Treatment options to manage both conditions concurrently were identified as a research gap. Integrated working between specialist healthcare teams was the supplementary strategy most frequently recommended. In the absence of a definitive treatment solution, clinicians are encouraged to use clinical reasoning along with support from specialist peers to establish the best, individualized treatment approach for their patients. 

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PLANTAR PRESSURE THRESHOLDS AS DFU PREVENTION STRATEGY

The development of ulcers in the plantar region of the diabetic foot originates mainly from sites subjected to high pressure. The monitoring of these events using maximum allowable pressure thresholds is a fundamental procedure in the prevention of ulceration and its recurrence. The aim of this systematic review was to identify data in the literature that reveal an objective threshold of plantar pressure in the diabetic foot, where pressure is classified as promoting ulceration. The aim is not to determine the best and only pressure threshold for ulceration, but rather to clarify the threshold values most used in clinical practice and research, also considering the devices used and possible applications for offloading plantar pressure.

The search was performed in 3 electronic databases, using the PRISMA methodology, for studies that used a pressure threshold to minimize the risk of ulceration in the diabetic foot. The selected studies were subjected to eligibility criteria.


Twenty-six studies were included in this review. Seven thresholds were identified, 5 of which are intended for the inside of the shoe: a threshold of average peak pressure of 200 kPa; 25 % and 40–80 % reduction from initial baseline pressure; 32–35 mm Hg for a capillary perfusion pressure; and a

Matrix of pressure thresholds for the plantar region stratified by risk level and European (EU) shoe size. Risk level: (0) low - no neuropathy, no history of ulceration or foot deformity; (1) medium - with neuropathy, but no history of ulceration or foot deformity; (2) high - with neuropathy and foot deformity, but no history of ulceration; (3) very high - with neuropathy, foot deformation, and history of ulceration.

Risk Level	EU shoe size	Pressure threshold (kPa)			
		Rearfoot	Midfoot	Forefoot	Toes
0-1	36/37	230	100	270	160
	38/39	200	90	240	150
	40/41	180	80	220	130
	42/43	160	70	200	120
	44/45	150	70	180	110
2	36/37	210	60	240	140
	38/39	180	60	220	130
	40/41	160	60	200	120
	42/43	140	60	180	110
	44/45	130	60	160	100
3	36/37	180	60	220	130
	38/39	160	60	190	120
	40/41	140	60	180	100
	42/43	130	60	160	100
	44/45	120	60	140	90

matrix of thresholds based on patient risk, shoe size and foot region (Table). Two other thresholds are intended for the barefoot, 450 and 750 kPa. The threshold of 200 kPa of pressure inside the shoe is the most agreed upon among the studies. Regarding the prevention of ulceration and its recurrence, the efficacy of the proposed threshold matrix and the threshold of reducing baseline pressure by 40–80% has not yet been evaluated, and the evidence for the remaining thresholds still needs further studies.

Conclusions: Some heterogeneity was found in the studies, especially regarding the measurement systems used, the number of regions of interest and the number of steps to be considered for the threshold. Even so, this review reveals the way forward to obtain a threshold indicative of an effective

steppingstone in the prevention of diabetic foot ulcer. Furthermore, it is important to highlight the need for a next stage in research, which could focus on additional refinements, such as determining specific thresholds based on the most critical locations in the plantar region while considering foot anatomy variations (such as size, type, deformities, among others). This additional step could be an important contribution to a more precise approach to preventing diabetic foot ulcers based on a certain threshold. 

Source: Castro-Martins P, Marques A, Coelho L, Vaz M, Costa JT. Plantar pressure thresholds as a strategy to prevent diabetic foot ulcers: A systematic review. *Heliyon*. 2024;10(4):e26161. doi: 10.1016/j.heliyon.2024.e26161.

Strengthening Program to Treat Plantar Heel Pain

BY JOHN W. A. OSBORNE, PHDC; HYLTON B. MENZ, PHD, DSC, BPOD(HONS); GLEN A. WHITTAKER, PHD, BPOD(HONS); AND KARL B. LANDORF, PHD

Addressing associated reduced muscle function and strength may improve treatment outcomes for plantar heel pain.

People with plantar heel pain (PHP) have reduced foot and ankle muscle function, strength, and size, which is frequently treated by muscle strengthening exercises. However, there has been little investigation of what exercises are used and there is no sound evidence base to guide practice. This study aimed to develop a consensus-driven progressive muscle strengthening program for PHP.

Methods

Thirty-eight experts were invited to participate in the study over 3 rounds. Round 1, an open-ended questionnaire, provided the core characteristics of progressive strengthening programs designed for 3 different adult patient types with PHP (younger athletic, overweight middle-aged, older), which were presented as vignettes. In Round 2, experts indicated their agreement to the proposed exercises and training variables. In Round 3, experts were presented with amendments to the exercises based on responses from Round 2 and indicated their agreement to those changes. Consensus was achieved when > 70% of experts agreed.

Results



In total, 24 (67%) experts participated in Round 1. Eighteen (75%) completed all 3 rounds. From Round 1, progressive strengthening programs were developed for the 3 vignettes, which included 10 different exercises and 3 training variables (sets/repetitions, weight, frequency). In Round 2, 68% (n = 17) of exercises and 96% (n = 72) of training variables reached consensus. In Round 3, only exercise changes were presented and 100% of exercises reached consensus.

Exercise prescription

Twenty-two (92%) respondents stated they would prescribe a progressive foot strengthening program for PHP. The 2 respondents who indicated they would not prescribe such a program agreed they would use a reloading

strategy in the right circumstances:

Strength training goals, indications, and contradictions

Seven themes were extracted regarding the goals of strength training exercises for PHP: addressing muscle weakness (n = 7), increasing tissue load/capacity (n = 6), reducing strain to the plantar fascia (n = 4), improving impact absorption of the foot (n = 3), improving function (n = 2), reducing arch deformation (n = 2), and reducing pronation (n = 1).

The 2 most common responses regarding indications for a progressive strengthening program were that it can be applied to all patients (n = 6) and to athletic or physically active individuals (n = 4). Only 3 contraindications were raised: the presence of a neurological (n = 1),

This article has been excerpted from “Development of a foot and ankle strengthening program for the treatment of plantar heel pain: a Delphi consensus study,” which appeared in the *Journal of Foot & Ankle Research*; 2023;16:67. <https://doi.org/10.1186/s13047-023-00668-2>. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC 4.0 International Licenses.

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Vignette (patient)	Stage	Exercise	Sets	Repetitions	Weight	Frequency
1. Younger athletic adult	Stage 1	Hallux plantarflexion banded	4	6 to 12	8 RM	Daily
		Digital plantarflexion banded	4	6 to 12	8 RM	Daily
		Heel raise	4	6 to 12	8 RM	Daily
		Short foot exercise seated	4	8 to 15	BW	Daily
	Stage 2	Toe spread out	3	8 to 15	BW	Daily
		Heel raise standing digits dorsiflexed	5	6 to 10	8 RM	Daily
		Short foot exercise standing single leg	3	8 to 15	BW	Daily
	Stage 3	Heel raise standing single leg digits dorsiflexed	5	8 to 15	10 RM	Daily
Walking lunges		3	12 to 25	20 RM	Daily	
2. Overweight middle-aged adult	Stage 1	Short foot exercise seated	4	8 to 12	10 RM	2nd daily
		Hallux plantarflexion banded	3	6 to 10	8 RM	2nd daily
		Lesser digit plantarflexion banded	3	2 min	BW	2nd daily
	Stage 2	Toe spread out	3	6 to 10	8 RM	2nd daily
		Heel raise standing digits dorsiflexed	5	6 to 10	8 RM	2nd daily
		Short foot exercise standing	3	6 to 10	8 RM	2nd daily
	Stage 3	Heel raise standing digits dorsiflexed	5	6 to 10	8 RM	2nd daily
		Walking lunges	3	12 to 20	15 RM	2nd daily
3. Older adult	Stage 1	Digital plantarflexion banded	4	8 to 12	10 RM	2nd daily
		Short foot exercise seated	4	8 to 12	10 RM	2nd daily
		Single leg standing	2	2 min	BW	2nd daily
	Stage 2	Toe spread out	3	6 to 10	8 RM	2nd daily
		Heel raise seated	5	6 to 10	8 RM	2nd daily
		Digital plantarflexion banded	3	6 to 10	8 RM	2nd daily
	Stage 3	Heel raise standing	3	6 to 10	8 RM	2nd daily
		Chair squat	3	6 to 10	8 RM	2nd daily

All participants begin on Stage 1 of the exercise regime. If there is no perceived difficulty or pain then progression to Stage 2 and so on for Stage 3
RM Repetition maximum, *BW* Body weight, 2nd daily = to perform every 2nd day

bone (n = 1), or fat pad (n = 1) pathology.

Exercise selection, muscles to be targeted, movement concepts

The most common exercises were heel raise variations (n = 10), digital plantarflexion (n = 8), and the short foot exercise (n = 8). The most common muscles to be targeted were foot intrinsics as a group (n = 6). Specific muscles mentioned included: calf (n = 2), flexor hallucis longus (n = 2), flexor digitorum brevis (n = 1), flexor digitorum longus (n = 1), tibialis posterior (n = 1), and adductors (n = 1)—although not defined as hip or foot adductors. Three themes emerged as movement concepts rather than specific exercises to be prescribed: applying a talar neutral position (n = 3), foot core (n = 1), and toe posture (n = 1).

Dosage variables, progression of exercise

The most common dosage variable used was

sets and repetitions (n = 14), followed by achieving a repetition maximum (n = 3), and time under tension (n = 2). The most common number of sets and repetitions was 3 (n = 5), 4 (n = 3), and 5 (n = 3) and 10, 12, and 15 (n = 5), respectively. The most common responses for progressing difficulty of exercise were to increase volume (n = 8), weight (n = 5), and complexity (n = 3).

Round 2

A 3-stage progressive strengthening program was derived from the results of Round 1 for each vignette. Eighteen (75%) experts completed Round 2, although 1 completed only the first vignette.

Younger athletic adult

Seven of 9 (78%) exercises achieved consensus. The exercises that did not achieve consensus were heel raise seated with digits dorsiflexed (67%) and short foot exercise while stand-

ing (67%). Twenty-six of 27 (96%) exercise training variables met consensus. The heel raise seated with digits dorsiflexed did not reach consensus for frequency of exercise (daily).

Overweight middle-aged adult

Five of 8 (63%) exercises achieved consensus. The exercises that did not achieve consensus were towel scrunch with inversion and eversion (59%), single leg standing on an unbalanced surface (53%), and short foot exercise seated (59%). Twenty-two of 24 (92%) exercise training variables reached consensus.

Older adult

Five of 8 (63%) exercises achieved consensus. The exercises that did not achieve consensus were towel scrunches (53%), towel scrunch with inversion and eversion (41%), and short foot exercise while seated (65%). All 24 exercise training variables reached consensus.

Progressions

The progressions of exercises and stages of the program did not reach consensus, with just 54% agreement. The progressions were based on increasing repetitions first, as follows: 'Each week the program progresses by adding 2 repetitions and keeping the weight and other variables the same. All participants begin on Stage 1 of the exercise regime. If there is no perceived difficulty or pain, then progression to Stage 2, and so on for Stage 3.'

Round 3

All 18 experts completed Round 3. The exercises that did not reach consensus in Round 2 were replaced in Round 3 with the exercises that were suggested most frequently by the experts in Round 2. For example, the towel scrunch with inversion and eversion did not meet consensus in Round 2 for the older adult (41%), so it was replaced with short foot exercise seated, which was the most frequently suggested replacement exercise. Following these replacements, all 3 progressive strengthening programs met consensus in Round 3.

Progressions

Exercise progressions were updated to increase weight and then functionality, rather than increase repetitions first, in response to expert feedback in Round 1. This progression strategy


achieved 100% consensus. The final progressive strengthening programs are presented in Table 1.

Discussion

Three exercises were consistently recommended throughout the study: heel raises, digital plantarflexion, and the short foot exercise, albeit with significant variation in how they were described and applied. Heel raises were the most commonly suggested exercise. However, a recent systematic review found that there is no difference in heel raise capacity between those with and those without PHP, so this recommendation may diverge from current evidence. Interestingly, both the heel raise and the heel raise with the digits dorsiflexed exercise variation were occasionally not recommended by some experts due to perceived difficulty or provocation of symptoms, indicating the need to better understand the role of exercises for PHP. Further, there is little robust evidence for the benefit of the exercise selections for those with PHP. Additionally, further research evaluating the effectiveness of increases in weight (within each stage of the progressive strengthening program) and functionality (between individual stages of the program) would be beneficial.

Conclusion

This study provides 3 progressive strengthen-

ing programs agreed to by experts that can be used in future clinical trials to determine the effectiveness of muscle strengthening for PHP. In addition, clinicians could use the programs as part of a rehabilitation strategy with the caveat that they may change as more research is conducted. 

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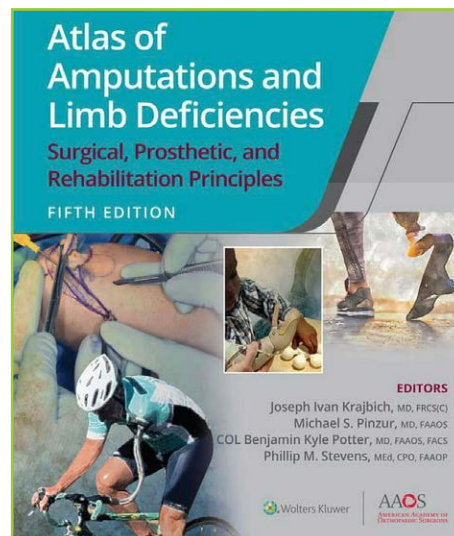
TAIKA3D, MOSAIC ANNOUNCE COLLABORATION

Finnish-based Taika3D, a global provider of custom orthotics software, announced its col-

laboration with Mosaic Manufacturing, Toronto, Canada, a provider of 3D printing solutions, aimed at elevating the design and manufacture of orthoses, cost-effectively and at scale. This collaboration optimizes Taika3D's design automation software for Mosaic's flagship product, Array, a high-volume 3D printing system.

The teams at Taika3D and Mosaic worked together to deliver a solution with automatic fused filament fabrication (FFF) optimizations in 3D printed outputs. The TaikaCreate solution can be fine-tuned for FFF print beds, self-generating supports, and nested build volumes. By leveraging Taika3D's automatic design software, complex custom foot orthotics models can be rapidly designed and validated. These models are then exported to the Mosaic system for printing. Array pairs seamlessly with Taika3D's software solution and can print up to 500 pairs of foot orthotics per month, per unit.

ATLAS OF AMPUTATIONS AND LIMB DEFICIENCIES



Atlas of Amputations and Limb Deficiencies: Surgical, Prosthetic, and Rehabilitation Principles, Fifth Edition, remains the definitive reference on the surgical and prosthetic management of acquired and congenital limb loss.

Developed in partnership with the American Academy of Orthopaedic Surgeons (AAOS), it discusses the most recent advances and future developments in prosthetic technology with in-depth treatment and management recommendations for adult and pediatric conditions. With coverage of every aspect of this complex field from recognized experts in amputation surgery, rehabilitation, and prosthetics, it is an invaluable resource for surgeons, physicians, prosthetists, physiatrists, therapists, and all others with an interest in this field. The text offers content updates throughout, with 12 new chapters, and features over 1,500 illustrations, photographs, and images. It provides decision support for amputation versus limb salvage, including treatment, management, and alternatives for all levels of limb loss.

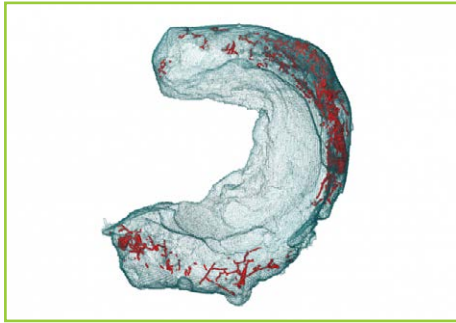
Wolters Kluwer

shop.lww.com

RESEARCHERS WORKING TO MAP THE MENISCUS

The 2 menisci per knee are susceptible to wear and injury, and the meniscus is generally not a favorable candidate for a surgical procedure because blood is only supplied in certain sections. Toward this end, researchers at Empa, the Swiss Federal Laboratories for Materials Science and Technology—doctoral student Federica Orellana and principal investigator of the project, Annapaola Parrilli, PhD—are using micro- and nano-computer tomography (CT), which can even go below the micrometer limit, to create a 3D map of the cartilage. From these radiological images, the researchers create mathematical models to record and map the density, structure, biomechanical deformability, and vascular network of cartilage in space. This work could optimize treatment and enable tailored therapies in the sense of personalized medicine.

Together with clinical partners at the Istituto Ortopedico Rizzoli in Bologna, the Can-



The meniscus and its network of blood vessels in a 3D rendering. The course of the blood vessels (red) is clearly visible.

tonal Hospital Winterthur, and the University of Zurich, the researchers are currently working with a large number of laboratory samples to build as meaningful a database as possible. Initial computer simulations already show the branching veins in the meniscus with promising precision. The micro-CT images convey the structural complexity of the meniscal tissue and, in the mathematical modeling, also allow further information such as the porosity or how strongly the blood vessels are tortuous.

Orellana is currently working on a 3D atlas of healthy meniscus tissue samples. In a next step, CT images of all kinds of injuries and wear and tear will be integrated into the models. The biophysicist said that the 3D map can be used for accident patients as well as for wear and tear processes in old age.

PROTECTIVE ATHLETIC SOCKS



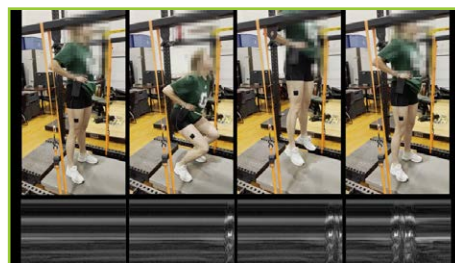
MediCaptain is an innovative sports protection brand that has released multiple sports

socks with unique metatarsal padding. This padding offers a pragmatic solution for athletes seeking enhanced foot support. These socks deliver special protection to the metatarsal bone, a common spot of injury in cleated sports like soccer and rugby. The incorporation of advanced grip technology ensures improved traction on various surfaces, promoting stability and reducing the likelihood of slips or falls. Designed from breathable materials, these socks prioritize ventilation and moisture management, addressing concerns related to discomfort and skin issues during prolonged use. With reinforced arch support, athletes benefit from proper foot alignment, potentially reducing fatigue associated with diverse sports. Durable and versatile, MediCaptain Lite Grip Socks cater to the functional needs of athletes, providing reliable support for optimal performance and maximum protection. Available in small to extra-large sizes.

MediCaptain

themedicaptain.com

WEARABLE ULTRASOUND MONITOR CAN AID REHABILITATION FROM INJURY



A wearable ultrasound monitor can provide insight into dynamic muscle movement during activities like jumping. Image courtesy of Parag Chitnis.

Parag Chitnis, PhD, of George Mason University led a team that developed a wearable ultrasound system that can produce clinically relevant information about muscle function during dynamic physical activity.

Many medical technologies can give doctors a window into the inner workings of

a patient's body, but few can be used while that patient is moving. A wearable ultrasound monitor can move with the patient and provide an unprecedented level of insight into body dynamics. "For instance, when an individual is performing a specific exercise for rehabilitation, our devices can be used to ensure that the target muscle is actually being activated and used correctly," said Chitnis. "Other applications include providing athletes with insights into their physical fitness and performance, assessing, and guiding recovery of motor function in stroke patients, and assessing balance and stability in elderly populations during routine everyday tasks."

To design the wearable ultrasound device, Chitnis and his team reinvented ultrasound technology nearly from scratch to produce the results they needed. "Traditionally, ultrasound systems transmit short-duration pulses, and the echo signals are used to make clinically useful images," Chitnis said. "Our systems use a patented approach that relies on transmission of long-duration chirps, which allows us to perform ultrasound sensing using the same components one might find in their car radio."

This modified approach allowed the team to design a simpler, less expensive system that could be miniaturized and powered by batteries. This let them design an ultrasound monitor with a small, portable form factor that could be attached to a patient. Chitnis hopes to further improve his device and develop software tools to more quickly interpret and analyze the ultrasound signals.

NEW INNOVATION DESIGNED TO ASSESS BALANCE

A new innovation by Chatchanee Pakavatsorn, a lecturer with Chulalongkorn University (Chula) Engineering, Thailand, checks body balance and balance loss for behavior changes and fall prevention to promote fall risk awareness and knowledge. The "Balance Assessment Device," with only 2 main components, namely



The award-winning Balance Assessment Device has received positive feedback from physicians and pediatricians. Image courtesy of Chula.

a standing platform and a USB cord, is not only user-friendly, but also compact, lightweight, and portable. The user can simply connect the USB cord to a tablet, a mobile phone, or a computer and then step onto the platform similar to a weight scale. The balance analysis result will then be displayed in real-time with Microsoft Excel.

“Apart from basic data such as weight and Body Mass Index, this device can also measure our balance area and distance,” said Pakavatsontorn.

The Balance Assessment Device has implications for a variety of users, including elderly people; athletes; fitness enthusiasts; people with balance issues; dancers who want to strengthen their legs; factory workers, and more. It can also be used to assess child development.

“This innovation is a simple tool that can assist the doctor in assessing fall risks among elderly people, encouraging behavioral changes, promoting fall prevention, and raising fall risk awareness and knowledge,” said Pakavatsontorn. “Anyone can use it to check their balance and status. It can help lighten the medical personnel’s load and create public well-being.”

The device is the gold medal winner at ITEX 2023, Malaysia, and recipient of World Invention Intellectual Property Associations’ (WIIPA) Special Award (Gold Medal).

NEW, IMPROVED KNEE BRACE FOR CHRONIC PAIN RELIEF



Bauerfeind’s new and improved GenuTrain A3 knee brace is designed for people living an active lifestyle who need support for chronic, mild to moderate knee osteoarthritis pain. The newly designed star-shaped patella pad with extra effective zones provides even better pain relief and helps stabilize the knee. Features include: anatomically contoured Train knit for optimized medical effectiveness, 2-component massage pad to stimulate the stabilizing knee muscles, indentations for greater adaptability and support during movement, Hoffa spots to target the Hoffa’s fat pad to promote self-healing and stabilization, integrated donning and doffing aids for easy application and removal, and stays with adaptable flex zone. Now available in black and with an additional size 7 suitable for patients with thigh circumferences up to 26 3/4 inches. Adjustments have also been made to the company’s sizing system, ensuring a better fit and enhanced comfort.

Bauerfeind USA

800/423-3405
bauerfeind.com/b2c

HANGER INC. ACQUIRES FILLAUER

Hanger Inc., a provider of orthotic and prosthetic (O&P) patient care services and solutions, announced that it has entered into an agreement to acquire Fillauer, an O&P manufacturer and

innovator. Fillauer is a family-owned company with a legacy of over 100 years.

“Bringing a manufacturing partner into the Hanger family will give us a better perspective earlier in the research and development phase, positioning us to drive innovation and proactively enhance patient outcomes,” said Pete Stoy, Hanger’s chief executive officer.

The transaction is expected to close in the first quarter of 2024. Financial details of the acquisition were not disclosed.

REHABILITATION SYSTEM FOR ADULTS WITH CHRONIC STROKE WALKING IMPAIRMENTS



MedRhythms’ InTandem (MR-001) is available by prescription for at-home use to improve walking and ambulation in adults living with chronic stroke walking impairments. This is an evidence-based neurorehabilitation system based on the principles of rhythmic auditory stimulation (RAS), an established and standardized intervention utilizing the mechanism of action of auditory-motor entrainment. Entrainment occurs when the motor and auditory systems in the brain unconsciously synchronize to an external cue, such as music. InTandem includes shoe-worn sensors, a headset, and a touchscreen device preloaded with the product’s software. In a clinical trial that was completed in 2023, InTandem users showed clinically meaningful and statistically significant improvements in gait speed as compared to an active walking control.

MedRhythms

medrhythms.com

SCALE THAT DETECTS EARLY DIABETES COMPLICATIONS



Body Pro 2 is a revolutionary device that redefines the nature and use of cellular-connected smart scales. It combines habit-forming user features with a pioneering modular approach to manage chronic conditions within one versatile device. Its core capabilities allow care teams to capture advanced health metrics such as weight and body composition while additional and optional health modules unlock the ability to track advanced and clinically validated biomarkers typically only available in a professional setting. Body Pro 2's first module is prescription-only (Rx) and aims to improve the way patients with diabetes are managed. With this module, care teams can monitor one of the biggest challenges in diabetes, diabetic foot health, which is often overlooked. By monitoring patients' electrochemical skin conductance, the scale may help to detect early signs of diabetic peripheral neuropathies and assess the risk for diabetic foot ulcers.

Withings Health Solutions
withingshealthsolutions.com

ACSM ANNOUNCES NEW EXERCISE ONCOLOGY SOCIETY

The American College of Sports Medicine (ACSM) announced that its 2024 Annual Meeting (May 28–31) will start off with a special preconference event: a Planning Meeting

for the International Society of Exercise Oncology. The target audience includes exercise oncology researchers (basic, clinical, translational, D&I, etc.), clinicians (MD/DOs, nurses, CEPs, PTs, OTs, palliative/supportive care doctors, integrative oncologists), fitness professionals with specialty training in oncology, trainees, people living with and beyond cancer, and sponsors (eg, equipment companies).

According to the ACSM, the field of exercise oncology has grown exponentially over the past several decades, and many, if not all, scientific meetings have less than 10 hours of exercise oncology programming, which is constraining development of the field and not reflective of the research and clinical expansion. The organizing committee proposes a discussion about the relative merits of forming the new International Society of Exercise Oncology with the intent of bringing the field together in a new way.

INFRARED RECOVERY COMPRESSION SOCKS



Comrad Socks recently unveiled its latest innovation, the Infrared Recovery Compression Socks. The infrared-infused fabric absorbs natural heat and reflects infrared energy back into the body, easing muscle fatigue and reducing swelling. This advanced feature not only provides users with the standard benefits of compression but also enhances healing and improves blood circulation. This combination ensures a holistic approach to circulation enhancement, making these socks an indispen-

sable tool for athletes, daily wearers, and those with specific circulation needs. After activity, wear the socks for at least 6 hours to receive full recovery benefit. Infrared and compression increase circulation, expediting muscle and tissue repair. Reduced muscle soreness allows for faster recovery.

Comrad Socks
comradsocks.com

DIABETIC HYDROGEL WOUND DRESSING, FIRST AID GEL



Lavior Pharma's Diabetic Hydrogel Wound Dressing and Diabetic First Aid Gel plant-based creams are rapid-healing creams, developed from groundbreaking wound care research. They are endorsed by the American Diabetes Association. The company's extensively researched medicinal botanical genus, Inula, and breakthrough technology are backed by 13 years of research as a natural treatment for a variety of skin disorders. Lavior Diabetic Hydrogel Wound Dressing helps maintain the ideal environment to help wounds heal faster. The Diabetic First Aid Gel is infused with targeted ingredients to address common diabetic injuries such as minor cuts, scrapes, and burns, offering immediate aid to help minimize the risk of infection and promote fast healing.

Lavior
305/627-3680
lavior.com

Resistance Training Improves Range of Motion

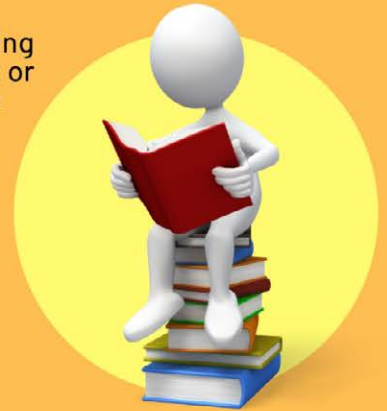
Reference: Alizadeh et al. Sports Med 2023

Designed by @YLMSportScience

55 studies were analysed to evaluate the effect of chronic resistance training on range of motion compared either to a control condition or stretch training or to a combination of resistance training and stretch training to stretch training



AND/OR



1 Resistance training can improve range of motion to a moderate magnitude except when it is completed using only body mass



2 Improvements in range of motion are not significantly different between resistance training and stretch training



3 Additional stretching prior to or after resistance training may not be necessary to enhance flexibility



Images provided by PresenterMedia

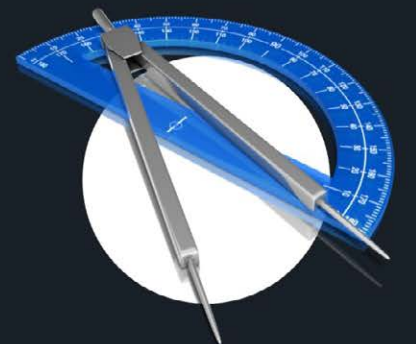
4 Although “trained or active people” increased range of motion moderately, “untrained and sedentary” individuals had significantly higher magnitude range of motion changes



5 There were no detected differences between sex and contraction type



6 No effect of age, training duration, or frequency were reported



Source: Alizadeh S, Daneshjoo A, Zahiri A, et al. Resistance training induces improvements in range of motion: a systematic review and meta-analysis. Sports Med. 2023;53(3):707-722. doi: 10.1007/s40279-022-01804-x.