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August 25 / volume 17 / number 8

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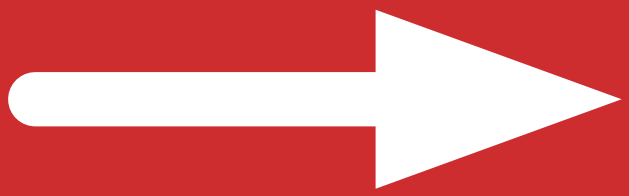

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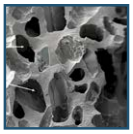

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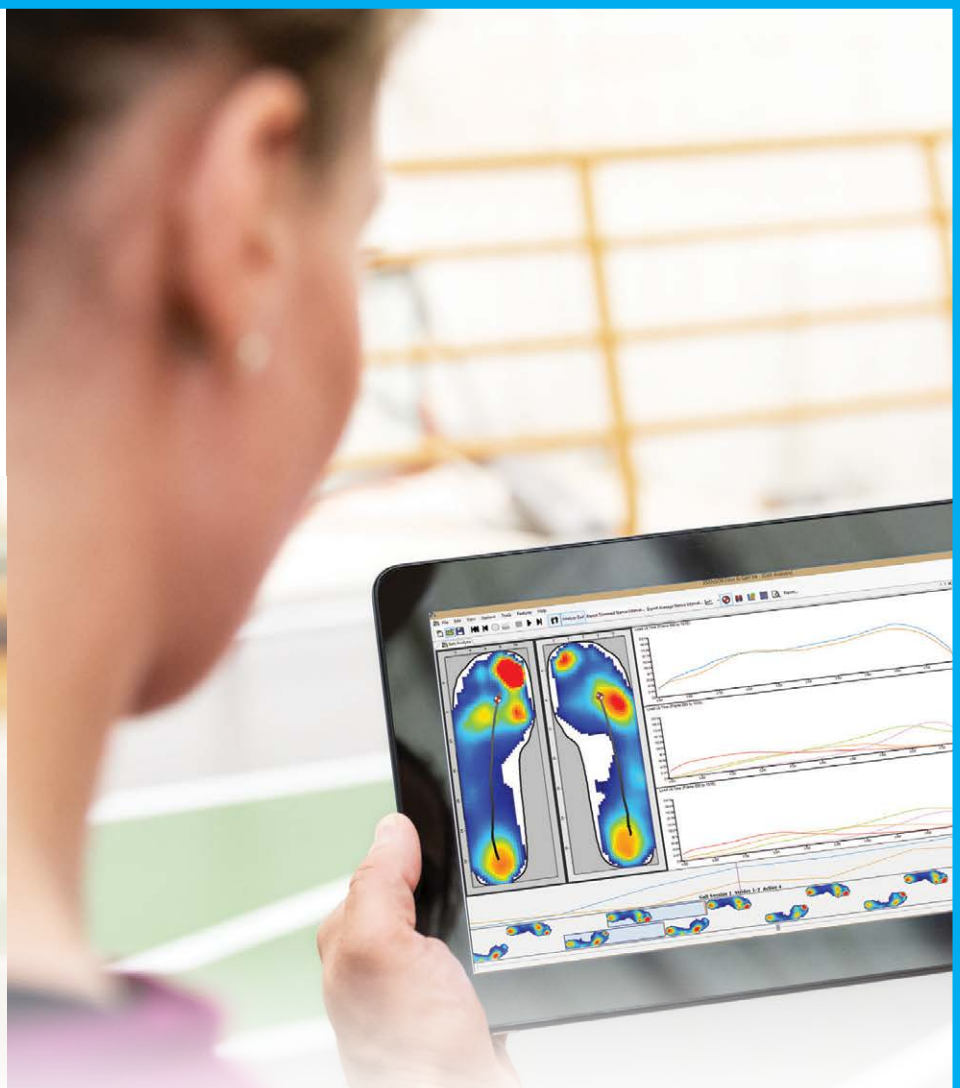

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Lower Extremity Review Mission

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

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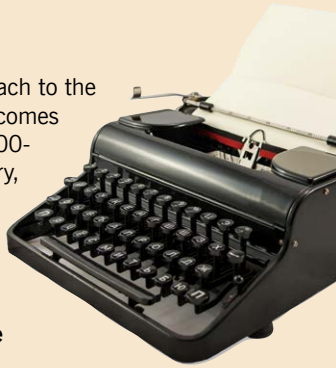

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SPORTS- AND RECREATION-RELATED TOE FRACTURES

Table 1. Incidence of Sports and Recreation Injury From 2013 to 2022.

Sports/Recreational Activity	Incidence Rate
Exercise and equipment	140.3
Bicycles and accessories	136.8
Basketball	136.8
Football	94.9
ATVs, mopeds, minibikes, etc	65.7
Playground equipment	65.4
Soccer	58.6

Abbreviation: ATVs, all-terrain vehicles.

Fractures of the toes are among the most frequently diagnosed lower extremity fractures. In sports, toe fractures may present after diverse mechanisms of injury, varying severity, and varying implications for management. This study aimed to discern trends in toe fractures presenting to US emergency departments (EDs) particularly in association with sports and recreational activities. An additional aim of the study was to identify if rates of toe fracture presentation significantly decreased during the year 2020 at the height of the COVID-19 pandemic.

The National Electronic Injury Surveillance System (NEISS) database was queried to identify toe fractures presented to US EDs from 2013 to 2022. The data outputs were analyzed by age group, sex, sport/recreational activity, and year. US Census data were used for calculation of incidence rates (IR) in 100,000 person-years. $\chi 2$ tests and regression analyses were performed to determine significance. Grubbs's test was performed to determine significant yearly outliers with particular attention to the year 2020.

A total of 921,033 toe fractures were identified across US EDs, with 175,864 cases associated with sports and recreation. Exercise (IR = 140.3) had the leading IR among sports/recreation followed by cycling (IR = 136.8), basketball (IR = 136.8), and football (IR = 94.9). Males accounted for 40.8% of fractures (IR = 23.0), whereas females contributed 59.2% (IR = 32.8). Toe fractures peaked in the 10- to 14-year-old age group in both males and females. Sports- and recreation-related toe fractures did not significantly decrease from 2013 to 2022, although all-cause toe fractures did significantly decrease as shown by a P value of .0037 from linear regression analysis of yearly trend in all toe fractures. The year 2020 was a significant outlier with a decrease in sports-related toe fractures though there was no significant decrease in all-cause toe fractures in 2020.

The authors concluded that sports- and recreation-related toe fractures did not significantly decrease from 2013 to 2022, although a significant decrease in all-cause toe fractures was observed. Toe fractures continue to peak in the pediatric age groups, particularly 10-14 year-olds. Youth sports and recreation officials should be aware of the risks of toe fractures to aid in prevention. ler

Source: *Norceide D, Onor GI Jr, Akingbola O, et al. The Epidemiology of Sports and Recreation Related Toe Fractures in the United States. Foot Ankle Orthop. 2025;10(2):24730114251342797. doi: 10.1177/24730114251342797.*

ARTHROSCOPIC BROSTRÖM-GOULD EFFECTIVE FOR CHRONIC ANKLE INSTABILITY

Functional score	Preoperative	Postoperative	t score	p-value
VAS	5.87 ± 1.92 (1-10)	2.0 ± 2.16 (0-7)	8.75	<0.0001
Karlsson-Peterson score	43.68 ± 13.2 (7-70)	69.21 ± 17.86 (37-100)	-8.71	<0.0001
AOFAS	62.53 ± 16.05 (29-83)	83.8 ± 11.49 (59-100)	-5.91	<0.0001

Table. Funtional scores of a chohort of 39 parents
The values are given as mean ± standard deviation (range).
VAS: visual analogue scale; AOFAS: American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Score.

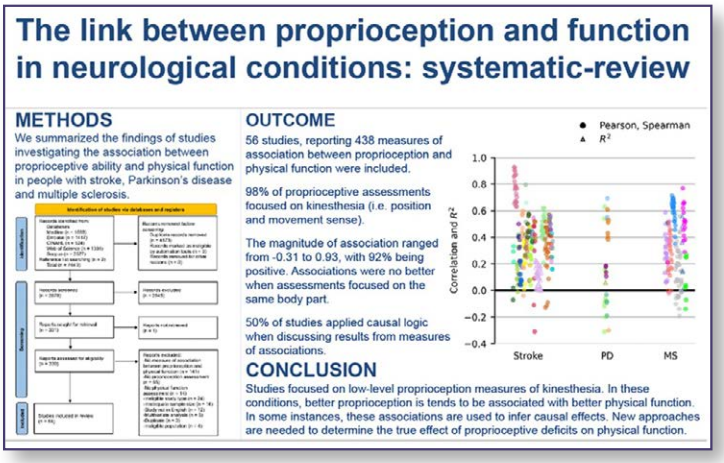
Chronic lateral ankle sprains are common injuries that are largely sequelae of inversion injuries of the ankle. These injuries are amenable to surgical intervention, namely, Broström-Gould reconstruction. Arthroscopic Broström-Gould surgery is a minimally invasive technique for treating chronic lateral ankle instability that offers several advantages over traditional open procedures, including better early pain relief, improved functional outcomes, and the ability to address concomitant ankle pathologies in a single session. It has a lower risk of wound complications but requires careful technique to avoid neurovascular injuries, particularly to the superficial peroneal nerve. Early postoperative weight bearing and rehabilitation protocols facilitate quicker recovery and return to sports, with long-term outcomes comparable to open surgery; however, further research is needed to confirm its durability and long-term effects such as osteoarthritis. A study involving 39 patients demonstrated significant improvements in pain and ankle function scores up to one year post-surgery, with no reported complications or recurrent instability, supporting its efficacy as a minimally invasive treatment option.

Early rehabilitation after arthroscopic Broström-Gould surgery typically involves immediate weight bearing and a full range of motion with an ankle brace, which is removed at six weeks postoperatively. This approach facilitates quicker functional recovery, wound healing, and stability assessment, contributing to improved outcomes as evidenced by significant improvements in functional scores (Table). ler

Source: *Mohamad H, Koh D, Socklingam R, et al. Clinical Outcomes After*

Arthroscopic Broström-Gould Procedure for Chronic Lateral Ankle Instability. Cureus. 2025;17(3): e81025. DOI 10.7759/cureus.81025

THE LINK BETWEEN PROPRIOCEPTION AND FUNCTION IN NEUROLOGICAL CONDITIONS: SYSTEMATIC-REVIEW



Source: *Robertson LS, Fisher G, Diong J, Butler AA, Gandevia SC, Héroux ME. The relation between proprioceptive ability and physical function in people with stroke, Parkinson's disease, and multiple sclerosis: a systematic review. J Appl Physiol (1985). 2025;139(1):167-184. doi: 10.1152/japplphysiol.00088.2025*

PEAK KNEE FLEXION ANGLE CAN IDENTIFY PERSONS POST-STROKE WITH STIFF-KNEE GAIT

Stiff-knee gait (SKG) affects 25–75% of individuals with post-stroke gait impairment and is typically defined as reduced swing phase knee flexion. Different studies use various measures to identify stiff-knee gait, such as peak swing knee flexion angle, timing of peak knee flexion, knee range of motion, and ankle push-off acceleration, leading to inconsistent results. The goal of this study was to determine the best single parameter biomechanical definition of post-stroke SKG. We conducted a univariate analysis approach to examine the independence, consistency, validity, and accuracy of the most common biomechanical metrics of SKG based on clinical judgement at 2 different gait speeds. Researchers then created threshold values of the best performing parameters for suggested clinical diagnosis.

This study used univariate cluster analysis to examine the independence, consistency, validity, and accuracy of different definitions in 50 post-stroke individuals (24 with and 26 without stiff-knee gait), as determined by a physiatrist. Spearman's rank correlation was used for correlation analysis, and 5 clustering techniques along with clinician evaluations were used for validity analysis.

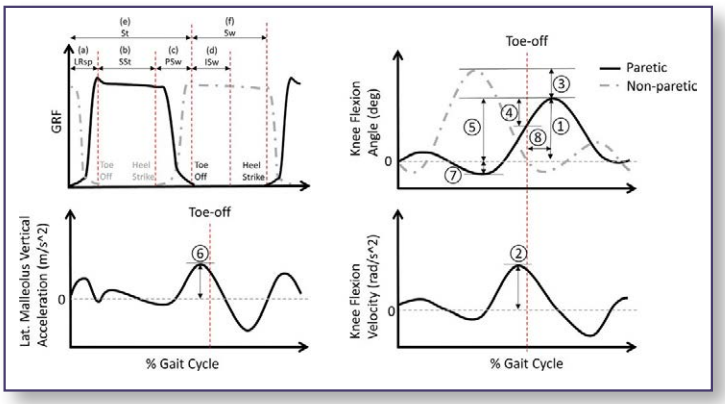


Figure. Gait phases and features associated with post-stroke SKGs. Gait phases (top left) are divided into a) Loading response (LRsp), b) Single-limb support stance (SSt), c) Pre-swing (PSw), d) Initial Swing–50 % of swing, (ISw), e) Stance (St), and f) Swing (Sw). Gait features from paretic side relevant to post-stroke SKG are 1) peak knee flexion in swing, 2) peak knee flexion velocity in pre-swing, 3) between-limb difference of peak knee flexion in swing), 4) knee range of motion in initial swing, 5) knee range of motion in full cycle, 6) peak push off acceleration in pre-swing, 7) timing of peak knee flexion in swing, and 8) peak knee extension in stance.

Correlation analysis showed that peak knee flexion timing and knee hyperextension are poorly correlated with reduced swing-phase knee flexion angle ($P = -0.09$ and $P = -0.26$ respectively). Validity analysis indicated that the between-limb difference in peak swing knee flexion angle and peak swing knee flexion angle at self-selected gait speeds were the most valid differentiators. At the fastest comfortable gait speed, the between-limb difference of peak knee flexion angle had the highest sensitivity, lowest specificity, and highest F1 scores.

We determined thresholds of less than 44.3° for peak swing knee flexion angle and greater than 17.0° for the between-limb difference of peak knee flexion angle identify stiff-knee gait during self-selected walking. We recommend using the difference in peak swing knee flexion angle between limbs to diagnose post-stroke stiff-knee gait due to its robustness to changes in gait speed. (ler)

Source: *Lee J, Lee RK, Seamon BA, Kautz SA, Neptune RR, Sulzer J. Between-limb difference in peak knee flexion angle can identify persons post-stroke with Stiff-Knee gait. Clin Biomech (Bristol). 2024;120:106351. doi: 10.1016/j. Use is per CC BY*

MUSCLE STRENGTHENING EXERCISE FOR FOOT & ANKLE BEST PRACTICES

Foot and ankle muscle strengthening exercises are common interventions for many musculoskeletal conditions associated with pain and limited function in the lower limb. While there is evidence to support a multitude of strengthening exercises, they have been criticized for not adhering to best practice and for being poorly reported. The aims of this scoping review were to describe recommended foot and ankle strengthening

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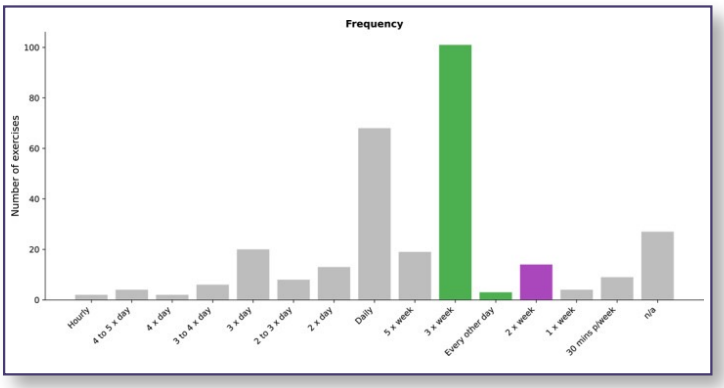

Figure 1. Frequency to perform individual prescribed exercises. Gray color indicates not meeting recommendations, green for meeting novice lifters, and purple for intermediate to advanced.

exercises, compare these exercises to best practice recommendations, and assess the completeness of the reporting of these exercises and exercise programs.

This scoping review was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews. A systematic search of peer-review journal articles was conducted on 23 February 2023. Study designs that were included were experimental, quasi-experimental, feasibility, pilot studies, and observational. For each study included in the review, study design and participant details such as age, sex, and conditions treated were noted. To describe the foot and ankle strengthening exercises, each exercise was noted, which included its name, the number of sets and repetitions recommended, the load type and its magnitude, and whether there were any progression strategies. Exercises were grouped according to primary movement and a general exercise descriptor. To compare to best practice, each program's prescription parameters of frequency, intensity, and time were compared to the American College of Sports Medicine's (ACSM) guidelines. To assess completeness of reporting, each study was assessed with the Consensus on Exercise Reporting Template (CERT).

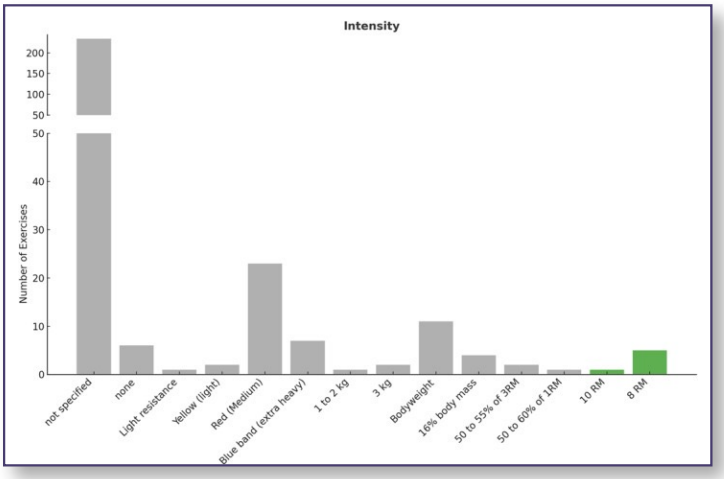

Figure 2. Load intensity of individual prescribed exercises. Gray color indicates not meeting recommendations, green for meeting novice lifters, and purple for intermediate to advanced.

The search yielded 1511 documents, and 87 were included after full-text screening. Of the included studies, most were randomized controlled trials, and the most common participants were healthy adults (mean age range: 18–83 years). Across all studies, a total of 300 foot and ankle exercises were prescribed. The most common strengthening exercise category involved ankle plantar flexion (25% of 300 exercises), followed by plantar foot intrinsics (16%). The most common prescription of strengthening exercises included 3 sets (37%) of 10 repetitions (38%) performed 3 times per week (34%), often without a prescribed load (66%). Prescribed sets per muscle group met ACSM recommendations for novice lifters in 93% of studies. In contrast, load intensity (for increasing muscle strength) was prescribed at the recommended dose of 60% of 1 repetition maximum or greater in only 2% of exercises. The median score for completeness of reporting according to the CERT checklist was 31% of all items.

This scoping review found that the studies predominantly included ankle plantar flexion and plantar foot intrinsic muscle strengthening exercises, typically prescribed at 3 sets of 10 repetitions, 3 times per week. When compared to best practice recommendations, load intensity in exercise prescription is commonly less than recommended or is not reported. In addition, the review highlights deficiencies in the reporting of exercise programs. The researchers propose using established best-practice exercise prescription guidelines like those from the ACSM and the adoption of CERT for reporting exercises in the scientific literature. ler

Source: *Osborne JWA, Menz HB, Whittaker GA, Cotchett M, Landorf KB. Muscle strengthening exercises for the foot and ankle: a scoping review exploring adherence to best practice for optimizing musculoskeletal health. J Foot Ankle Res. 2025;18(2):e70040. doi: 10.1002/jfa2.70040. Use is per CC BY 4.0.*

POSITIVE OUTCOMES OF MEDIAL ARCH AND HINDFOOT RECONSTRUCTION IN CHILDREN

Although surgical alignment of the rear-foot might be sufficient to achieve acceptable correction of pronation-distortion deformity, concomitant correction of the medial arch might improve functional results.

This study represents the authors' experience with combined hind-foot alignment and medial arch reconstruction by in-situ naviculo-cuneiform arthrodesis for treatment of flexible flatfoot in children. We retrospectively evaluated clinical data available from pediatric (< 18 years old) patients treated for flexible flatfoot in our department.

We performed 160 surgical corrections of flat foot in 94 children over the study period. Median age was 13 (range, 12–14) years. All patients had a minimum postoperative follow-up of 24 months. Overall postoperative outcomes were optimal in 82% (n = 113/160) of cases, good in 15% (n = 24/160) of cases, and adequate in 3% (n = 3/160) of

cases. At 24-month follow-up, complete surgical correction of deformity was achieved in 89% (n = 143/160) procedures. Complete consolidation of arthrodesis was achieved within 3 months form surgery in 84% (n = 134/160) of cases, between 3 and 6 months in 12% (n = 21/160) of cases. There was a significant difference in pre-operative AOFAS score among the different weight categories ($P < 0.001$). At post-hoc analysis, OB patients had lower AOFAS versus NW or OW patients. At 24-months follow-up, there was a significant difference in AOFAS scores among the different weight categories ($P = 0.04$). At post-hoc analysis, OB patients had lower AOFAS versus OW patients. There was no difference in AOFAS scores at final follow-up ($P = 0.12$). Postoperative pain was absent in 88% (n = 140/160) of cases.

At a minimum 24-month follow-up, patients who undergo flat-foot deformity correction using a surgical technique combining sinus tarsi arthroeresis and medial arch reconstruction by naviculocuneiform arthrodesis experience good short-term results.

Source: *De Marchi F, Crippa IA, Anghilieri FM, Familiari F, Mazzantini S, Jackson GR, Chahla J, Monti L. Benefits of combined hind-foot alignment and medial arch reconstruction surgery in children with flexible flatfoot: a case-series analysis. Arch Orthop Trauma Surg. 2025;145(1):259. doi: 10.1007/s00402-025-05831-x. Use is per CC BY 4.0.*

FIREFIGHTERS' EXPOSURE FOOTWEAR IMPACTS LOWER LIMB WALKING BIOMECHANICS

This study, by researchers from Shanghai, China, investigates the biomechanical and muscular impacts of firefighting boots (EFF) compared to standard or training footwear (FTS) during walking and related activities. The research highlights that EFF boots, characterized by their stiffness and design, restrict ankle and toe joint range of motion,

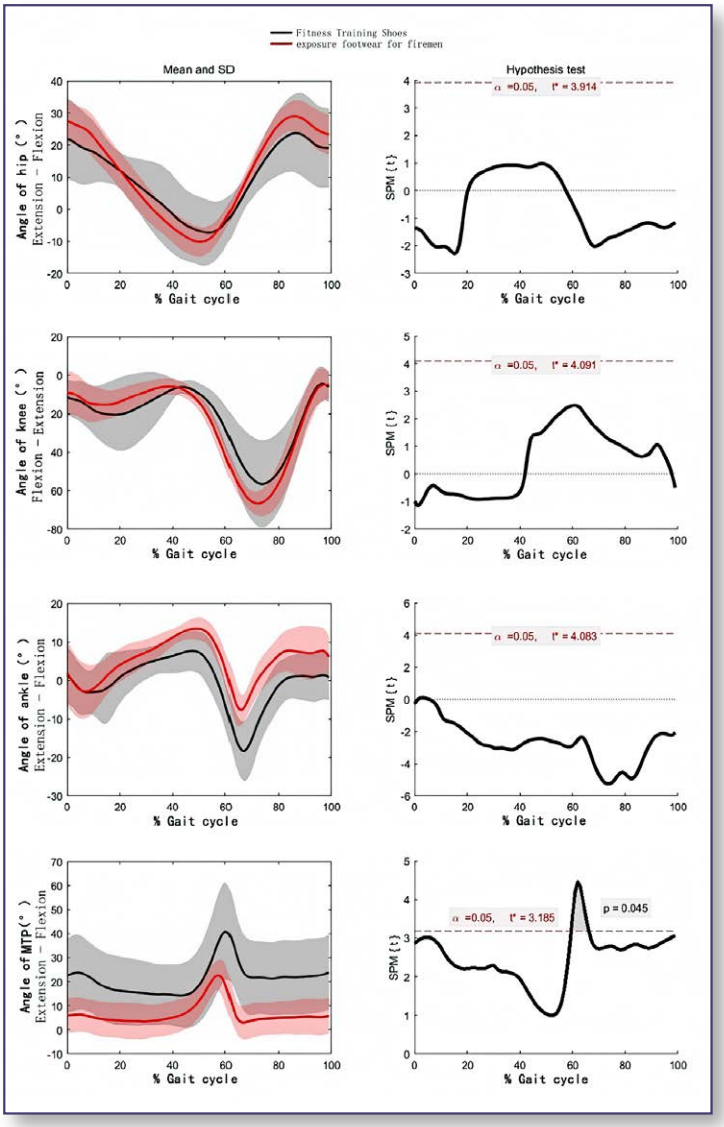

Figure. The sagittal plane angular profiles of hip, knee, ankle, and MTP joints during the gait cycle for participants wearing different footwear on the left side. Positive and negative values indicate the direction: positive values represent hip flexion, knee extension, and ankle and MTP joint dorsiflexion, while negative values represent hip extension, knee flexion, and ankle and MTP joint plantarflexion. The corresponding SPMID statiscs results are presented on the right side.

leading to increased muscle activation in muscles such as the rectus femoris and tibialis anterior. These biomechanical alterations result in higher joint moments and energy demands, which may elevate the risk of musculoskeletal injuries, fatigue, and osteoarthritis over time. The findings emphasize the need for improved boot designs with lighter, more flexible materials and suggest targeted strength training to mitigate injury risks among firefighters.

Source: *Duan J, Xie C, Hong Y, Zhang S. Effects of using exposure footwear for firemen and fitness training shoes on lower limb biomechanics during walking. Sci Rep. 2024;14(1):28881. doi: 10.1038/s41598-024-77407-5. Use is per CC BY.*

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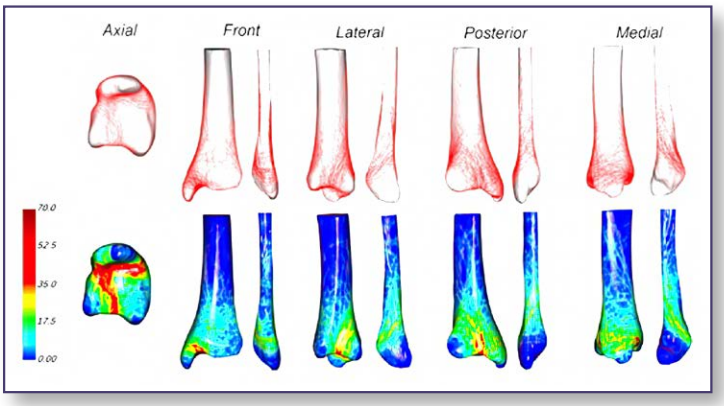
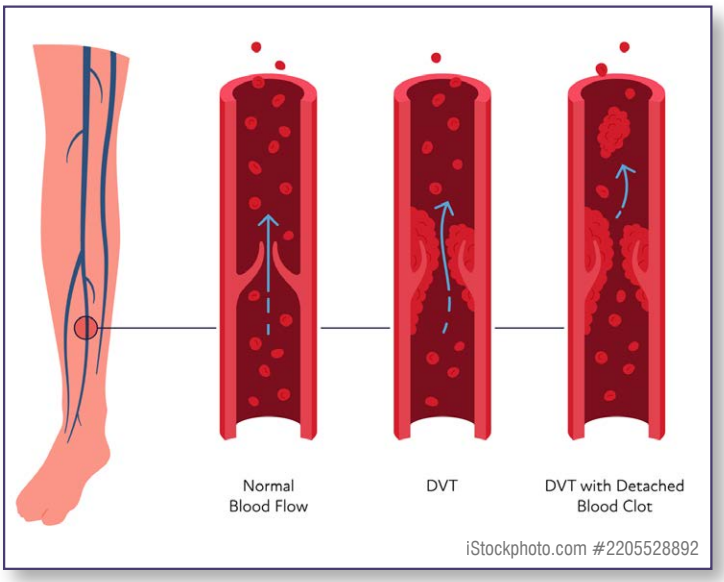
3D MAPPING OF FRACTURE LINE MORPHOLOGY OF PILON FRACTURES



In this study, the morphological characteristics of Pilon fractures were clarified in detail by 3D mapping. This provides a basis for the diagnosis, classification, selection of treatment methods, internal fixation design, and statistical analysis of fracture lines of Pilon fractures. ler

Source: *Liu J, Piao C, Cui G, Sun H, Li Z. Fracture Line Morphology and a Novel Classification of Pilon Fractures. Orthop Surg. 2025 Feb;17(2):540-550. doi: 10.1111/os.14304.*

BIOMARKER CANDIDATES TO PREDICT DVT AND HEALING AFTER ACHILLES RUPTURE



Deep venous thrombosis (DVT) and poor long-term patient outcomes frequently occur in patients with Achilles tendon rupture (ATR). Biomarkers for DVT and their possible relationship to long-term healing outcomes remain unexplored. To identify DVT biomarkers from proteomic profiles during the inflammatory and proliferative healing stages and assess their associations with one-year healing outcomes after surgical repair of ATR. A cohort of 53 patients undergoing standardized ATR repair from previous clinical trials was investigated. Intraoperative inflammatory-stage tendon biopsies were obtained from 40 patients, and tendon microdialysates from 28 patients were collected two weeks later during the proliferative stage. Liquid chromatography-tandem mass spectrometry proteomic profiles were linked to DVT status at two weeks post-surgery using ultrasonography screening and to patient-reported outcomes at one-year post-surgery. Six candidate DVT biomarkers were identified from tendon biopsies, whereof four (ABI3BP, IGKV2-40/IGKV2D-40, PCYOX1, STIP1) were associated with one-year healing outcomes. In tendon microdialysates, 43 candidate DVT biomarkers were identified, but none were associated with healing outcomes. Bioinformatic analysis revealed pathways related to heat shock response, platelet signaling, collagen and extracellular matrix metabolism, and immunoglobulins. The results support shared inflammatory-stage protein pathways in regulating venous thrombosis and reported healing outcomes, where elements of individual hypoxic tolerance and platelet signaling emerge as potential key links. ler

Source: *Saarensilta A, Chen J, Reitzner SM, Hart DA, Ahmed AS, Ackermann PW. Novel tissue biomarker candidates to predict both deep venous thrombosis and healing outcome after Achilles tendon rupture. Sci Rep. 2025;15(1):7318. doi: 10.1038/s41598-025-91511-0.*

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Orthobiologics and Bone Substitutes: A Primer

By Asim Raja, DPM, FACFAS

Orthobiologics is the science of harnessing and concentrating substances (substrates) that occur naturally in the body. It is theorized that in higher concentrations, biologics may help to enhance (or) improve the healing process.

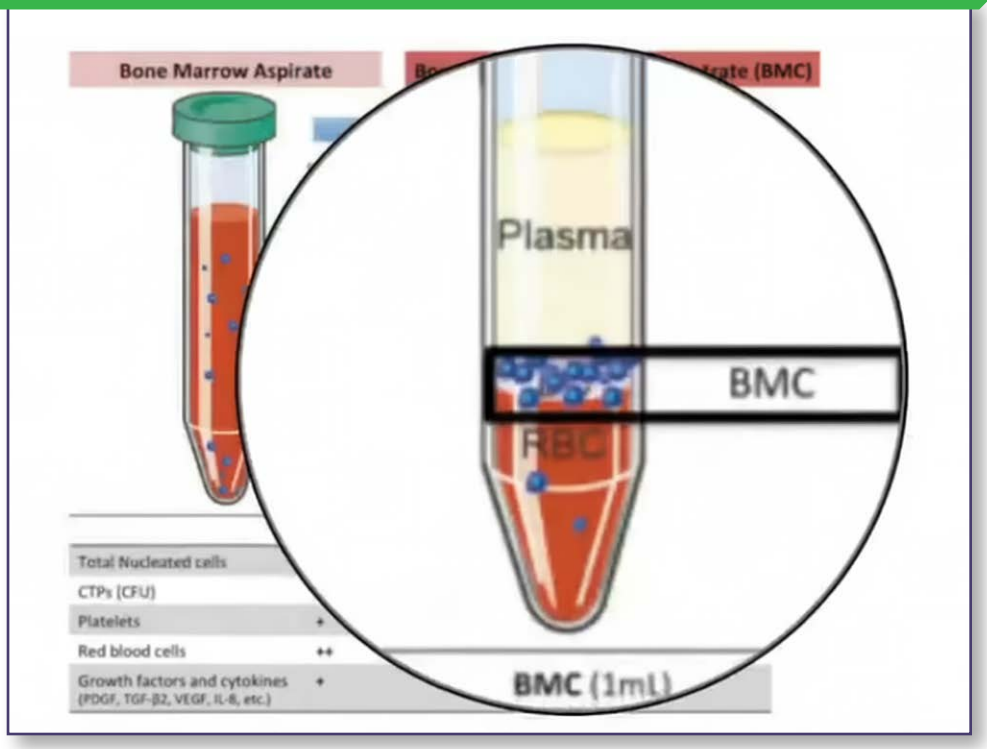


Figure 1. Bone marrow aspirate concentrate (BMC) is obtained by one or multiple bone marrow aspiration (BMA) centrifugations. After centrifugation (density separation), the buffy coat (BC), which lies in between the plasma and the red blood cells (RBC) containing most of the nucleated cells, (some of which are stem and progenitor cells), platelets, growth factors, and cytokines is obtained.

Source: Piuzzi NS, Khlopas A, Newman JM, Ng M, Roche M, Husni ME, Spindler KP, Mont MA, Muschler G. Bone Marrow Cellular Therapies: Novel Therapy for Knee Osteoarthritis. J Knee Surg. 2018 Jan;31(1):22-26.

Orthobiologics and bone substitutes represent groundbreaking advancements in regenerative medicine. They focus on enhancing the body's natural healing processes by utilizing naturally occurring substrates like cells, scaffolds, and signaling molecules. These elements work together to accelerate recovery from bone fractures and other tissue injuries. The U.S. Food and Drug Administration (FDA) classifies these biologic products as "human cells, tissue, and cellular/tissue-based products" (HCT/P), emphasizing their role in transplantation and repair. By concentrating these biologically active components, orthobiologics offer promising medical solutions for improved bone healing and tissue regeneration.

The Science Behind Biologics

Biologics are transformative in the medical field, offering advanced solutions for bone healing by harnessing the body's natural substrates. Understanding the scientific foundations and regulatory aspects of biologics is crucial for both practitioners and patients.

FDA Classification and Definition: The FDA classifies biologics under "Human Cells, Tissues, and Cellular/Tissue-Based Products" (HCT/P). This broad category includes any articles containing or consisting of human cells or tissues intended for implantation, transplantation, infusion, or transfer into a human recipient. This classification emphasizes the natural origins of these products and the necessity for regulation in their usage, ensuring they are minimally manipulated and maintain their intended purpose.

The "3 S's" of Biologics: The concept of biologics is best explained through the 3 key components: Cell, Scaffold, and Signal, often compared to a construction site.

- **Cell:** These are akin to workers, where immature cells like mesenchymal stem cells can differentiate into specialized bone cells essential for healing.
- **Scaffold:** Serving as the framework, scaffolds provide the necessary structure

This article is a summary of Dr. Raja's presentation, "Orthobiologics and Bone Substitutes," from the 35th Annual No-Nonsense Seminar, held March 7-9, 2025. To view the full presentation with questions and answers—and see the agenda for the 3-day program, visit visit https://nononsense2025.lerexpo.vcom. Continuing education credits are available for this and many other lerEXPO programs.

for cells to adhere, migrate, and grow, facilitating the healing process.

- **Signal:** Similar to a foreman, signals direct the activity of cells, guiding them through the healing process.

Types and Sources of Cells in Biologics: Cells utilized in biologics are categorized into undifferentiated cells, like mesenchymal stem cells which have the potential to mature into osteocytes or chondrocytes, and mature cells with defined roles. Bone marrow and adipose tissue are prime sources for these cells, offering accessibility and a high concentration of precursor cells. The process of creating Bone Marrow Aspirate Concentrate (BMAC) involves a centrifuge to concentrate these cells, enhancing their availability for therapeutic applications.

Scaffolds in Bone Healing

Scaffolds are integral to bone healing, providing the physical support necessary for cell integration and tissue regeneration. They come in various forms, each with its own advantages and challenges.

Autogenous bone grafts, harvested from the patient, provide a robust scaffold because of their osteogenic, osteoinductive, and osteoconductive properties. However, they require an additional surgical site and are limited in availability. Alternatively, allografts, sourced from donors, negate donor site morbidity and are readily available, though they pose a risk of disease transmission and potential immune reactions.

Synthetic bone grafts, such as those made from bioactive glass, calcium sulfate, and tricalcium phosphate (TCP), are engineered to mimic the bone's natural structure, with bioabsorbables designed to integrate and resorb over time. Metallic implants, often 3D printed using materials like titanium, promote osteointegration and long-term bone integration, although their success depends on factors such as pore size and surface preparation.

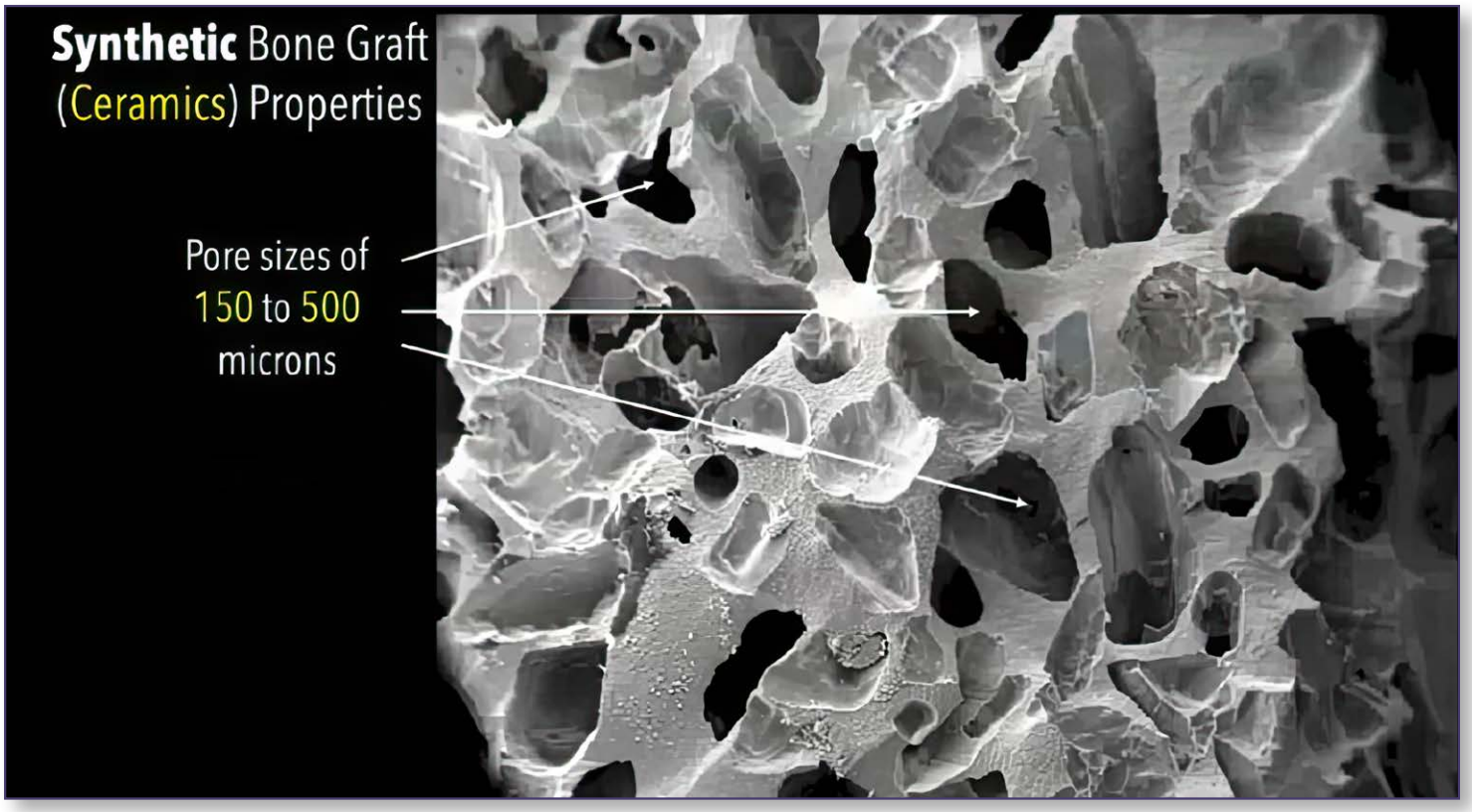
Soft tissue scaffolds involve the use of tendon and nerve allografts, typically stripped of cells and signals, serving purely as structural intermediaries to aid in repair and regeneration. Skin substitutes, often in sheet form, support skin growth and are primarily used for treating wounds, providing an essential scaffold in regenerative medicine.

Signals and Their Roles in Healing

Understanding how signals work in biologics is crucial to maximizing their potential in enhancing bone healing and regeneration. Primary signaling agents involved in these processes include:

Cytokines play a significant role in directing the healing process. Produced mainly by leukocytes or white blood cells, they facilitate communication between cells during immune responses and inflammation. Examples include interleukins and interferons, which are pivotal in combating infections and regulating cellular activities.

Growth factors are predominantly released by activated platelets. They are essential for stimulating cell growth, proliferation, and differentiation. For example, Platelet-Derived Growth Factor (PDGF) and Transforming Growth Factor-beta (TGF-beta) are crucial for bone growth and tissue repair. Vascular Endothelial Growth



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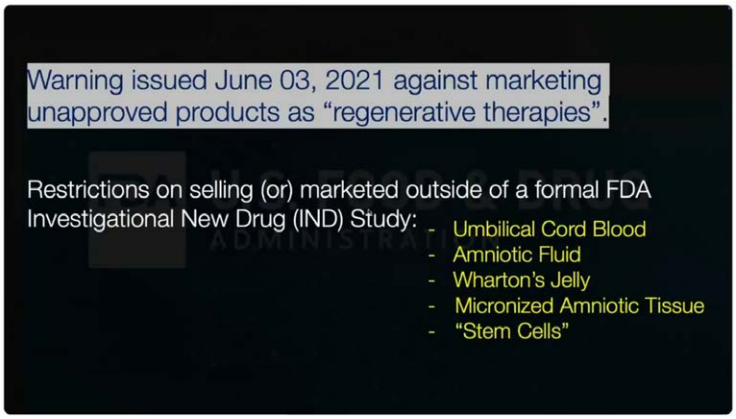

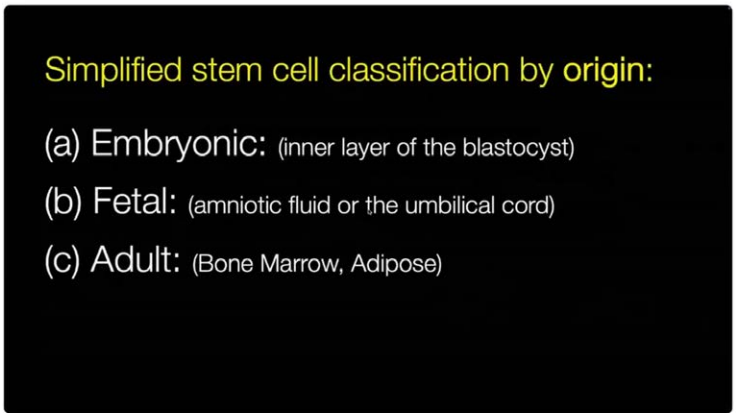

Factor (VEGF) promotes the formation of new blood vessels, enhancing nutrient delivery to healing tissues.

Platelet-Rich Plasma (PRP) formulations have become a cornerstone in augmenting healing in both orthopedic and podiatric applications. PRP is derived by centrifuging a patient's blood to concentrate platelets and growth factors. This results in various formulations, including leukocyte-rich PRP, which is beneficial for tendon healing due to its inflammatory response, and platelet-pure plasma, preferred for joint injections to minimize inflammation.

Demineralized Bone Matrix (DBM) is rich in proteins, particularly Bone Morphogenetic Proteins (BMPs), such as BMP-2 and BMP-7, known for their ability to induce bone formation. BMPs are osteoinductive, meaning they signal immature cells to develop into bone-forming cells, facilitating the repair and regeneration of bone material.

Regulatory and Practical Considerations

Navigating the regulatory landscape is essential for practitioners using orthobiologics and bone substitutes to ensure compliance and optimal patient outcomes.

The FDA classifies biologics as Human Cells, Tissues, and Cellular/Tissue-Based Products (HCT/P). However, there are notable regulatory gaps, as the FDA does not mandate verification of cell concentrations or the homogeneity of biologic products. This oversight can lead to significant variability in product efficacy and consistency.

Marketing Restrictions: The FDA imposes restrictions on marketing claims for biologics, particularly those promising "regenerative" outcomes. Additionally, they restrict the approved sources for adult stem cells to bone marrow or adipose tissue, ensuring careful consideration of product claims and sourcing.

Practical Applications in Podiatry and Orthopedic Surgery

In clinical practice, understanding the nuances of product claims and the regulatory landscape helps practitioners make informed decisions. For instance, PRP formulations can be tailored to specific injuries or conditions, such as using leukocyte-rich formulations for tendons or platelet-pure formulations for joint environments. In podiatry and orthopedic surgery, orthobiologics serve as adjunctive tools, enhancing natural healing processes when applied within a well-considered treatment plan.

For successful applications, practitioners should focus on optimizing the patient's overall biological health, creating favorable conditions for orthobiologics to exert their maximal therapeutic effect. This holistic approach ensures improved healing outcomes and patient satisfaction.

> Orthobiologics and bone substitutes represent groundbreaking advancements in regenerative medicine.

Conclusion

In summary, orthobiologics and bone substitutes represent pioneering advancements in regenerative medicine, offering promising avenues for enhanced bone healing. By leveraging the body's natural substrates and processes, biologics such as cells, scaffolds, and signals work in concert to support the repair and regeneration of damaged tissues. However, these innovations are largely adjunctive, meaning they serve to complement existing healing processes rather than replace them outright. Success in using these medical solutions is highly contingent upon optimizing the patient's biological environment, addressing any underlying health issues, and selecting the right combination of biologic components. As scientific research and technological advancements continue to unfold, the potential uses for these biologic products are expected to expand, providing more targeted and effective treatment options for bone-related medical conditions.

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EXPERT GUIDANCE

Beating the Heat: Back to School Takes Preparation

By Ciara L. Taylor, EdD, LAT, ATC

Approximately 9,000 high school athletes are treated for heat-related illnesses every year in the United States.[1]

Back-to-school means back-to-sports for many students around the country. With the return of sports, health and safety guidelines must be in place. The National Athletic Trainers' Association recommends 6 strategies for Exertional Heat Stroke (EHS) preparedness including: 1) hydration access; 2) emergency response plan enacted for school athletics; 3) policy with instructions for initiating emergency medical reservices response; 4) trained athletic training staff for recognition and treatment of EHS; 5) immersion tub filled with ice water before start of practice; 6) monitor wet-bulb globe temperature.[2]

Hot temperatures can make outdoor activity challenging. Proper hydration and nutrition are essential to beat the heat. Water and sports drinks are vital for fluid replacement due to sweat loss. Sports drinks contain essential electrolytes, such as sodium and potassium, to aid in hydration. Young athletes should drink at least half their body weight in ounces per day. For example, an athlete that weighs 160 pounds should drink at least 80 ounces of water daily. Urine color that is light yellow like lemonade, not apple juice, is a key sign of hydration. Proper hydration must be implemented before, during, and post activity.

There should be mindful considerations made regarding weather, time of day, length of activity, equipment, clothing, and rest breaks. Heat index and/or wet-bulb globe must be monitored and tracked. Heat index is air temperature and humidity. Wet-bulb globe factors include ambient temperature, humidity, wind speed, sun angle, and cloud cover. There are instruments and applications available to track the wet-bulb globe temperature. Exertional heat illness is one of the leading causes of death for athletes, yet it is 100 percent preventable!

Heat illness is a spectrum of disorders that are caused by increased body temperature (see box). It can derive from environmental conditions and/or exertion. Heat illness includes conditions such as heat cramps, heat syncope, heat exhaustion and heat stroke. Signs and symptoms of exertional heat illness are headache, dizziness, confusion, disorientation, excessive sweating, fatigue, chills, nausea, vomiting, increased heart rate, rapid breathing, low blood pressure, and/or seizures. A core body temperature greater than 105 is extremely dangerous and can cause life-threatening complications.

To combat heat illness, cold water immersion is required. The rule of thumb is cool first, transport second. Cold tubs, kiddie pools, tarps or body bags are the most effective way to rapidly cool young athletes. Core body temperature should be monitored and should reach below 102 degrees before transporting to a local hospital. If a rectal thermometer is not available, an athlete should be cooled for a minimum of 30 minutes.

5 Tips to Help Beat the Heat

1. Collaborate with athletic trainers to ensure best practices for health and safety
2. Establish venue-specific emergency action plans
3. Communicate with local emergency medical

HEAT ILLNESS IS A SPECTRUM OF DISORDERS

- *Heat cramps — involuntary muscular spasms*
- *Heat syncope — orthostatic dizziness or fainting*
- *Heat exhaustion — overheating of the body due to inability to cool itself*
- *Heat stroke — severe overheating; body ceases control of temperature*

services prior to the start of the season to review and practice Emergency Action Plans

4. Have cold water immersion available (water and ice) daily
5. Educate coaches, parents, and athletes on proper hydration and nutrition. (ler)

Ciara L. Taylor, EdD, LAT, ATC, is Secondary School Athletic Trainers' Committee Chair for the National Athletic Trainers' Association (NATA).

Resources

1. National Athletic Trainers Association: Beat the Heat: Dehydration and Heat Illnesses Handout: https://www.nata.org/sites/default/files/2025-08/hydration_heat_illness_handout.pdf
2. US Centers for Disease Control and Prevention. Heat Health: Heat and Athletes: https://www.cdc.gov/heat-health/risk-factors/heat-and-athletes.html
3. National Athletic Trainers Association: AT Your Own Risk https://www.atyourownrisk.org/
4. National Federation of State High School Athletic Associations: Wet Bulb Globe Temperature (WBGT)- Why Should Your School Be Using It? https://nfhs.org/stories/wet-bulb-globe-temperature-wbgt-why-should-your-school-be-using-it

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5. Heat and Teenage Athletes. U.S. Environmental Protection Agency. Available at https://www.epa.gov/children/heat-and-teenage-athletes. Accessed Aug. 13, 2025.
6. Kerr ZY, Scarneo-Miller SE, Yeargin SW, et al. Exertional Heat-Stroke Preparedness in High School Football by Region and State Mandate Presence. J Athletic Training. 2019;54(9):921–928. doi: 10.4085/1062-6050-581-18.

Related ShortTakes

PREVENTING EXERTIONAL HEAT STROKE IN FOOTBALL: NEW PARADIGM FOCUSES ON LINE POSITIONS

Among American sports, football has the highest incidence of exertional heat stroke (EHS), despite decades of prevention strategies. Based on recent reports, 100% of high school and college EHS football fatalities occur during conditioning sessions. Linemen are the at-risk population, constituting 97% of football EHS deaths. Linemen heat up faster and cool down slower than other players.

These authors identified case series from organized, supervised football at the youth, high school, and collegiate levels and compiled in the National Registry of Catastrophic Sports Injuries. Sources for event occurrence were media reports and newspaper clippings, autopsy reports, certificates of death, school-sponsored investigations, and published medical literature. Articles were identified through PubMed with search terms "football," "exertional heat stroke," and "prevention."

Football EHS is tied to (1) high-intensity drills and conditioning that is not specific to individual player positions, (2) physical exertion as punishment; (3) failure to modify physical activity for high heat and humidity, (4) failure to recognize early signs and symptoms of EHS, and (5) death when cooling is delayed.

To prevent football EHS, the authors concluded, (1) all training and conditioning should be position specific; (2) physical activity should be modified per the heat load; (3) understand that some players have a "do-or-die" mentality that supersedes their personal safety; (4) never use physical

Continued from page 21

exertion as punishment, (5) eliminate conditioning tests, serial sprints, and any reckless drills that are inappropriate for linemen; and (6) consider air-conditioned venues for linemen during hot practices. To prevent EHS, train linemen based on game demands. ler

Source: *Anderson SA, Eichner ER, Bennett S, et al. Preventing Exertional Heat Stroke in Football: Time for a Paradigm Shift. Sports Health. 2025;17(3):484-490. doi: 10.1177/19417381241260045.*

FOOTBALL LINE POSITION INCREASES HEAT RISK COMPARED TO BMI

A study focusing on high school football players in Georgia revealed that player position, particularly linemen, is a more significant predictor of exertional heat illnesses (EHIs) such as heat exhaustion than BMI. The research found that linemen are over twice as likely to experience heat-related issues compared to backs and specialists, emphasizing the importance of implementing position-specific heat safety protocols and training to mitigate risks during athletic activities.

Data were collected from 22 Georgia high schools as part of normal practice/competition activities. There were 309 EHIs over 163,118 athlete-exposures. The linemen group had over 2.5 to 3 times greater risk of sustaining heat syncope/heat exhaustion (HS/HE) than the backs (relative risk [RR], 2.63; 95% CI, 1.59-4.33) and Specialists (RR, 3.16; 95% CI, 1.52-6.56) groups. Linemen were at lower risk for exercise-associated muscle cramps (EAMCs) compared with backs (RR, 0.63; 95% CI, 0.53-0.76). No differences were found in relative risk among BMI categories.

Coaches can tailor heat safety training by emphasizing the higher risk associated with specific positions, such as linemen, and implementing position-specific strategies. For linemen, training should focus on hydration, acclimatization, and monitoring for early signs of heat exhaustion, given their increased risk. Additionally, educating all players about the importance of recognizing symptoms and adjusting activity levels based on position-related risk can enhance safety. Incorporating position-specific cooling strategies and ensuring adequate rest periods are also recommended to mitigate heat-related illnesses. ler

Source: *Cahill OJ, Cooper ER, Grundstein AJ. Can Body Mass Index Values and/or Player Position be Viable Predictors for Exertional Heat Illness in American Football Players? Sports Health. 2025:19417381251350670. doi: 10.1177/19417381251350670.*

CHILDREN SWEAT JUST LIKE ADULTS

A recently published study from Australia sought to determine whether children (aged 10–16) are at greater risk of hyperthermia and dehydration than adults (aged 18–40) during exercise in hot conditions and to assess how well an adult sweat-rate calculator estimates children's sweat rates.

They had 68 active children and 24 adults perform 3 separate 45-minute treadmill sessions under 2 environmental conditions while core temperature was continuously monitored and dehydration was assessed by changes in body mass.

Key takeaways included: 1) children and adults respond similarly in terms of core temperature increases and dehydration when exercising in hot conditions (up to 104 degrees F); 2) an adult-derived sweat-rate calculator estimates children's sweat lossess quite accurately; 3) to promote safety, hydration behavior remains critical—even if physiological risk levels are similar between kids and adults.

The authors concluded that practitioners can potentially reduce behavioral dehydration risks from inadequate fluid consumption using an existing adult sweat rate calculator for children. ler

Source: *Smallcombe JW, Topham TH, Brown HA, et al. Thermoregulation and dehydration in children and youth exercising in extreme heat compared with adults. Br J Sports Med. 2025 Jul 31;59(16):1151-1159. doi: 10.1136/bjsports-2025-109832.*

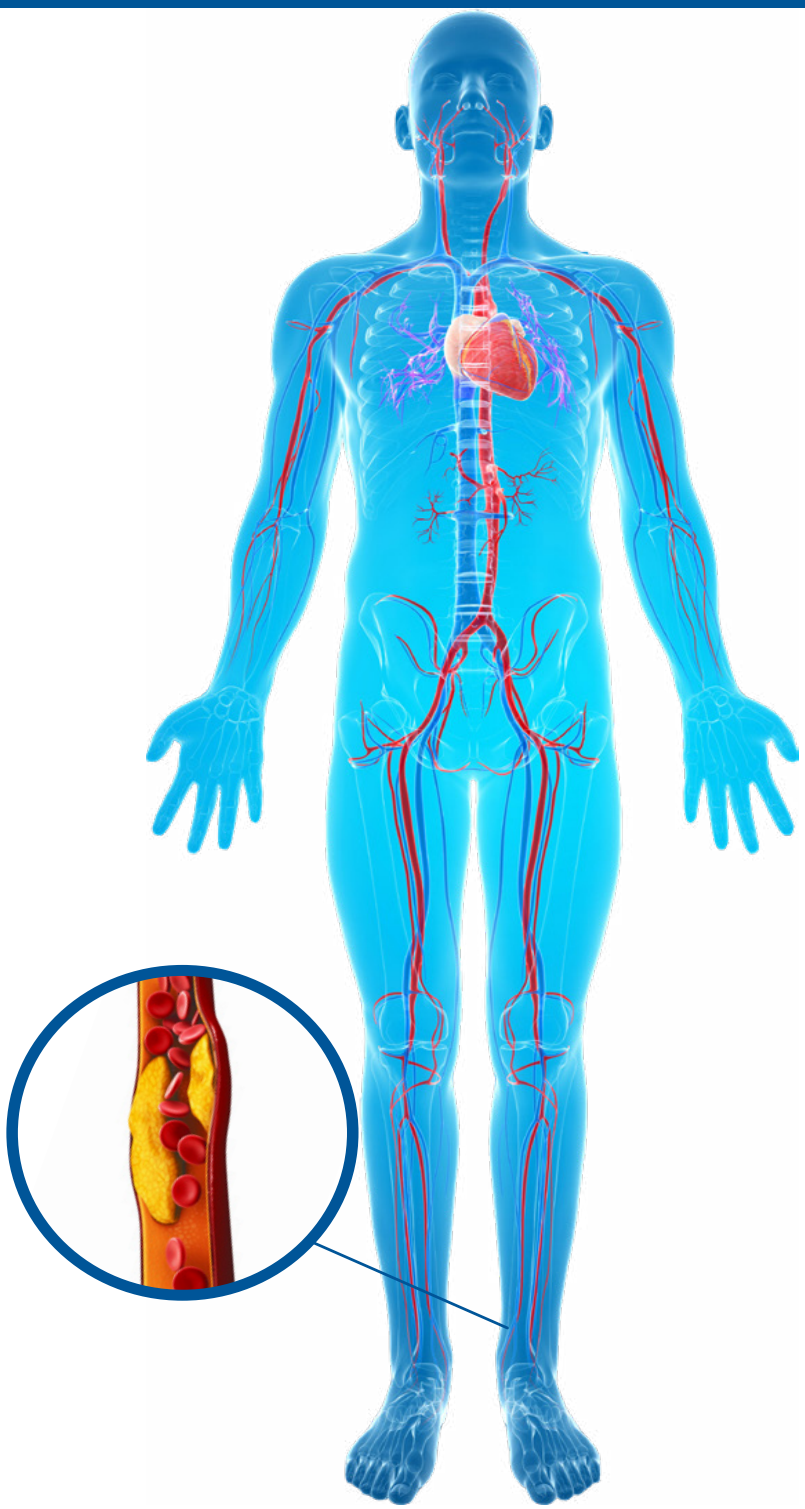
Peripheral Artery Disease

Peripheral Artery Disease (PAD) is a deadly chronic condition that can lead to heart attack, stroke, or amputation.

1 in 3

- » Diabetics age 50+
- » Smokers age 50+
- » Everyone age 70+

Have PAD



$390 billion

annual US healthcare costs attributable to PAD

100,000 amputations

of lower extremities in the US annually, due to vascular disease

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Dog-Item-Related Falls Affecting the Lower Extremity Treated at United States Hospital Emergency Departments

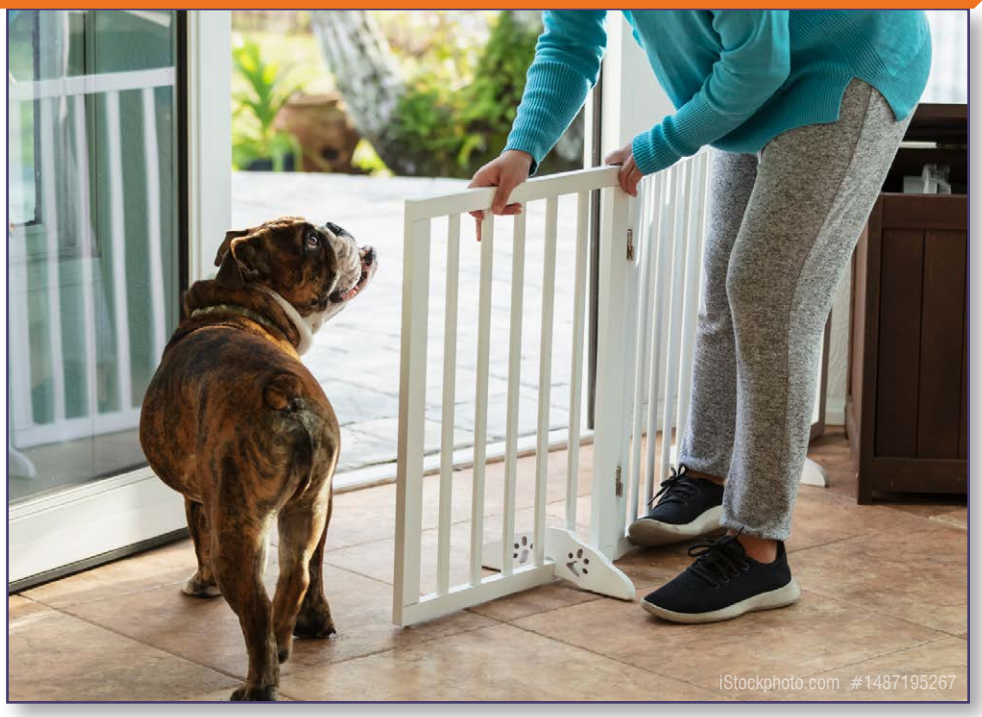
By Mathias B. Forrester, BS

Background: Millions of families in the United States (US) own dogs, and with these dogs comes an assortment of dog items (gates, beds, toys, etc.). Tens of thousands of falls associated with dogs are treated at US hospital emergency departments (EDs) each year, a portion of which involve dog items. The objective of this study is to describe dog-item-related falls affecting the lower extremity treated at US hospital EDs.

Methods: Dog-item-related falls affecting the lower extremity during 2000–2023 were identified using the National Electronic Injury Surveillance System (NEISS), a database of consumer product- and activity-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 dog-item-related falls affecting the lower extremity was determined for patient demographics, injury circumstances, and management.

Results: Of an estimated 175,451 total dog-item-related falls treated at US hospital EDs during 2000–2023, 51,978 (29.6%) affected the lower extremity. The specific item was 23.8% gate, door, or fence; 22.4% toy; 10.5% bed, mat, blanket, or pillow; 9.5% urine; 8.0% bowl or dish; and 25.9% other and unknown. The patients were 76.9% female, and 31.4% were aged 60 years or older. Strain or sprain was reported in 34.2% of the estimated falls, followed by fracture (30.9%), contusion or abrasion (15.0%), laceration (4.8%), and other or not stated (15.2%). The patient was treated or evaluated and released in 88.5% of the estimated injuries.

Conclusion: The dog items involved in almost 75% of falls affecting the lower extremity were gate, door, or fence; toy; bed, mat, blanket, or pillow; urine; and bowl or dish. Over three-quarters of the patients were female, and over 30% of patients were aged 60 years or older. The most frequently reported injuries were strain or sprain, fracture, and contusion or abrasion. Most patients were treated or evaluated at the ED and released. The information in this study may assist healthcare providers and others to identify those individuals most at risk for dog-item-related falls affecting the lower extremity and creating plans to manage and prevent these injuries.



According to the 2025 American Pet Products Association (APPA) National Pet Owners Survey, 68 million United States (US) households owned a dog,[1] although dog ownership declined from 54% in 2020 to 44% in 2024.[2] With dogs comes an assortment of related items, such as gates or fences, beds, toys, cages or kennels, food, and dishes, as well as urine and feces.

Tens of thousands of falls associated with dogs are treated at US hospital emergency departments (EDs) each year. According to one study, 9% of all dog-related falls involved a pet item.[3]

The objective of this study is to describe dog-item-related falls affecting the lower extremity treated at US hospital EDs.

Methods

The data source for this descriptive epidemiologic study was the National Electronic Injury Surveillance System (NEISS), available at: https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS database has been described in detail in *Lower Extremity Review* previously.[4] To summarize, operated by the US Consumer Product Safety Commission (CPSC), NEISS is a database of consumer product- and activity-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.[5,6] Since the data are publicly available and de-identified, the study is exempt from institutional review board approval. The NEISS database has been used for previous dog-item-related injury investigations,[4,7-10] including a previous study published in *Lower Extremity Review* that examined dog-related falls affecting the lower extremity.[11] However, this previous study did not include dog-item-related injuries, except for leashes. The present study includes the dog-item-related injuries excluded from the previous study.

Cases were dog-item-related falls affecting the lower extremity reported to the NEISS database during 2000–2023. The NEISS database includes 3 numeric fields for coding the product or activity involved in the injury. The database has a product code field 1715 (Pet supplies).

Table 1. Dog-item-related falls affecting the lower extremity treated at United States emergency departments, National Electronic Injury Surveillance System, 2000–2023, by type of item

Item*	Estimate	%	95% CI
Gate, door, or fence	12,360	23.8	9,221-15,498
Toy	11,619	22.4	8,627-14,611
Bed, mat, blanket, or pillow*	5,481	10.5	3,778-7,184
Urine	4,932	9.5	3,353-6,510
Bowl or dish	4,145	8.0	2,750-5,541
Bone	3,539	6.8	2,288-4,789
Cage, kennel, crate, or carrier	3,259	6.3	2,077-4,442
Pee pad*	1,780	3.4	978-2,581
Water spilled from dog bowl	1,201	2.3	560-1,842
Food (loose or in package, not bowl)	939	1.8	-
House	613	1.2	-
Feces	477	0.9	-
Stairs or ramp	369	0.7	-
Vomit	344	0.7	-
Other and unknown**	920	1.8	-
Total	**51,978**		**42,003-61,952**

*If record Narrative mentions pad but not pee pad, it is included in the Bed, mat, blanket, or pillow category.

**Includes tie or anchor for dog leash, hair, saliva, exercise equipment, fluid from birth, grooming device, medication, urine and feces combined, bath, tunnel.

Estimate = 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.

However, preliminary analysis indicated that this product code was not used in almost one-quarter of potential cases. Moreover, the code does not distinguish between dog supplies and supplies for other pets nor does it indicate the specific type of pet supply. Instead, the Narrative text field (a text field that provides a summary of the circumstances and type of injury) was used to identify cases in a manner like that used in the previous dog-related fall article.[11]

The identification of cases was performed in stages. First, to identify as many dog-item-related injuries as possible, the NEISS database was searched for all records that included the following letter groups in the Narrative field:

"dog," or "pup," or "airdale," or "Akita," or "Malamute," or "shep," or "hound," or "beagle," or "terrier," or "collie," or "doodle," or "poodle," or "boxer," or "spaniel," or "mastiff," or "Corso," or "chihuahua," or "corgi," or "dachshund," or "dalmatian ," or "dober," or "labrador," or

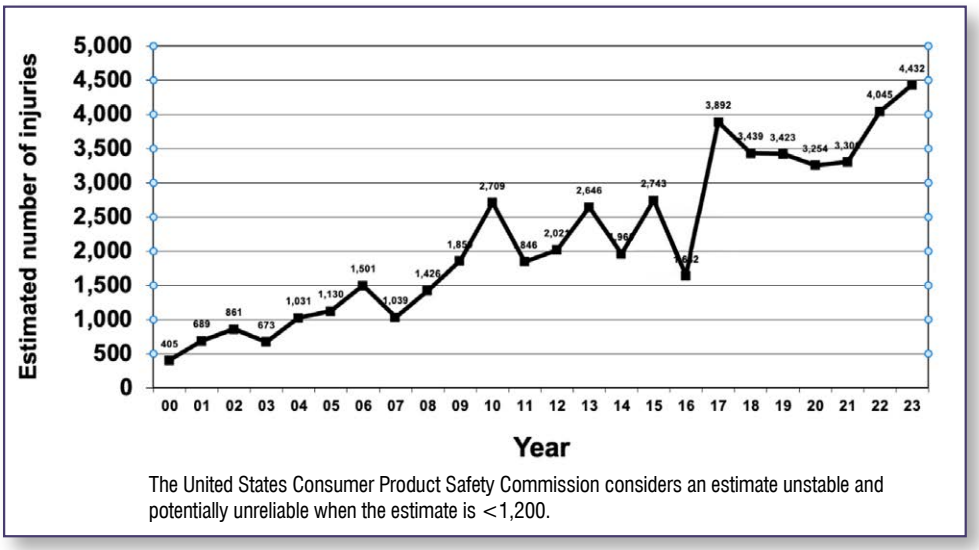


Figure 1: Annual estimated number of dog-item-related falls affecting the lower extremity reported to the National Electronic Injury Surveillance System, 2000-2023

"retriever," or "dane," or "Pyrenees," or "husky," or " setter," or "Maltese," or "schnauzer," or "dalmatian," or "Pomeranian," or "pug," or "rottw," or "rotw," or "Bernard," or "shar p," or "sharpie," or "shih," or "tzu," or "weim," or "whippet," or "pitbull," or "pit bull"

These letter groups were used because the dog might have been identified solely as a puppy or by breed. The letter groups were included in the names of some of the more common dog breeds and are not considered to be comprehensive.

Second, to identify as many falls as possible, this subset of records was searched for all records that included the following letter groups in the Narrative field:

"fall," or "fell," or "trip," or "slip," or "knoc," or "nock," or "down," or "push," or "pull," or "foos," or "T'D&F," or "TD&F," or "S'D&F," or "SD&F," or "bump," or "ran into," or "run into," or "stumb," or "jump," or "land," or "crash," or "collid," or "collis"

Third, the Narrative fields of the resulting second subset of records were individually reviewed to determine whether they appeared to represent dog-item-related falls. If so, the specific dog item was noted. Items used for or by the dog as well as items produced by the dog, such as urine, feces, and vomit, were classified as dog items. Records were included if the Narrative indicated a trip or slip even if a fall was not explicitly stated. In addition, records were included if the person fell into or onto something other than the ground (eg, wall, stairs, furniture). Records were excluded if the dog item was a leash, because injuries involving a leash were included in the previous dog-related fall study.[11]

Finally, dog-item-related falls affecting the lower extremity were identified. The NEISS database contains 2 numeric fields for coding the affected body part (Body_Part and Body_Part_2) and 2 numeric fields for coding the type of injury or diagnosis (Diagnosis and Diagnosis_2). The Body_Part_2 and Diagnosis_2 fields were added in 2018, although they do not appear to have been used until 2019.[6] For consistency over the entire study period, the Body_Part and Diagnosis fields alone was examined for the analysis. Only those records where the Body_Part field contained codes for a part of the lower extremity (upper leg, knee, lower leg, ankle, foot, toe) were included in the study.

The variables examined were dog item, treatment year and month, location where the incident occurred, patient age and sex, type of injury (diagnosis), affected body part, and disposition. Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database. The 95% confidence intervals (CIs) were calculated for the estimates. The distribution of estimated injuries was calculated for each variable. The CPSC considers an estimate unstable and potentially unreliable when the estimate is <1,200.[5] For those variable subgroups where the estimate was <1,200, 95% CIs were not calculated.

Results

A total of 1,132 dog-item-related falls affecting the lower extremity were identified, resulting in a national estimate of 51,978 dog-item-related falls affecting the lower extremity. These represented 29.6% of the estimated 175,451 dog-item-related falls affecting all body parts. In comparison, the previous study of dog-related falls found an estimated 335,446 falls affecting the lower extremity.[11] Thus, if the estimated dog-related and dog-item-related falls affecting the lower extremity were combined, dog-item-related falls would account for 15.5% of the estimated total.

Table 1 shows the distribution of dog-item-related falls affecting the lower extremity by type of item. The most frequently reported items were gate, door, or fence; toy; bed, mat, blanket, or pillow; urine; and bowl or dish. Together, these 5 groups accounted for 74.1% of all dog-item-related falls affecting the lower extremity.

Although the annual estimated number of dog-item-related falls affecting the lower extremity varied from year to year, the general trend was an increase over the 24-year period (Figure 1). The estimated number of dog-item-related falls affecting the lower extremity in 2023 was 11 times that in 2000. The seasonal distribution of dog-item-related falls affecting the lower extremity was 11,249 (21.6%) in January–March, 13,555 (26.1%) in April–June, 13,218 (25.4%) in July–September, and 13,955 (26.8%) in October–December.

Table 2 presents the estimated number of dog-item-related falls affecting the lower extremity by patient demographics and location of the incident. The estimated number of falls increased with older age groups with 31.4% occurring in patients 60 years and older. Most of the patients were female. The majority of falls occurred at home.

Table 2. Dog-item-related falls affecting the lower extremity treated at United States emergency departments, National Electronic Injury Surveillance System, 2000-2023, by patient demographics and location of incident

Variable	Estimate	%	95% CI
Patient age (years)			
0-5	874	1.7	-
6-12	1,958	3.8	1,109-2,807
13-19	2,262	4.4	1,333-3,192
20-29	4,296	8.3	2,865-5,727
30-39	5,848	11.3	4,062-7,633
40-49	8,317	16.0	5,998-10,635
50-59	12,108	23.3	9,019-15,197
60+	16,315	31.4	12,416-20,214
Sex			
Female	39,986	76.9	31,955-48,017
Male	11,992	23.1	8,926-15,057
Location of incident			
Home	42,576	81.9	34,119-51,033
Other public property	380	0.7	-
Place of recreation or sports	223	0.4	-
School	6	0.0	-
Not recorded	8,793	16.9	6,375-11,211
Total	**51,978**		**42,003-61,952**

Please see full footnote on Table 1.

Table 3 shows the estimated number of dog item-related falls affecting the lower extremity by injury type (diagnosis) and disposition. The most frequently reported injuries were strain or sprain, fracture, contusion or abrasion, and laceration. The most commonly affected body part was the knee followed by the ankle and foot. Most patients were treated or evaluated at the ED and released; however, over 10% were treated and admitted for hospitalization at the same hospital or treated and transferred to another hospital.

Discussion

Dog-item-related falls affecting the lower extremity account for roughly 16% of all dog- and dog-item-related falls affecting the lower extremity.[11] Nevertheless, such dog-item-related falls affecting the lower extremity result in hundreds to thousands of US hospital ED visits each year.

Moreover, the number of US hospital ED visits due to dog-item-related falls affecting the lower extremity is growing; this study found that the estimated annual number of these falls has increased by more than an order of magnitude between 2000 and 2023. The previous study of dog-related falls affecting the lower extremity likewise observed an increase in US hospital ED

Table 3. Dog-item-related falls affecting the lower extremity treated at United States emergency departments, National Electronic Injury Surveillance System, 2000-2023, by type of injury (diagnosis) and disposition

Variable	Estimate	%	95% CI
Injury type (diagnosis)			
Strain or sprain	17,777	34.2	13,604-21,949
Fracture	16,045	30.9	12,197-19,893
Contusion or abrasion	7,805	15.0	5,594-10,015
Laceration	2,471	4.8	1,488-3,455
All other/not stated*	7,880	15.2	5,653-10,106
Body part			
Knee	16,613	32.0	12,658-20,568
Ankle	15,820	30.4	12,014-19,625
Foot	7,313	14.1	5,207-9,418
Lower leg	5,639	10.8	3,901-7,378
Upper leg	3,611	6.9	2,343-4,879
Toe	2,982	5.7	1,869-4,096
Disposition			
Treated or examined and released	46,008	88.5	36,992-55,024
Treated and admitted for hospitalization (at same facility)	4,916	9.5	3,341-6,492
Treated and transferred to anotherhospital	579	1.1	-
Held for observation	110	0.2	-
Left without being seen/Left against medical advice	365	0.7	-
Total	**51,978**		**42,003-61,952**

*Includes crushing, dislocation, hematoma, nerve damage, puncture, avulsion. Please see full footnote on Table 1.

visits.[11] Additional studies found increases in dog leash-related injuries, including those affecting the lower extremity, leash-dependent dog walking-related injuries, and fractures in elderly adults while walking leashed dogs.[4,8,9,12] The increase in injuries may be due to an increase in dog ownership in the US. The estimated number of pet dogs increased from 72.1 million in 2006 to 76.8 million in 2016.[13] However, this 7% increase in dogs between 2006 and 2016 is much smaller than the observed increase in dog-item-related falls affecting the lower extremity. Furthermore, the percent of US dog ownership has declined between 2020 and 2024.[2] It may be that the number of dog items per household with a dog has increased or people are becoming more likely to experience dog-item-related falls that result in a US hospital ED visit.

Although a variety of items were involved in dog-item-related falls affecting the lower extremity, all items were not equally likely to result in falls. Two of the categories–gate, door, or fence and toy–accounted for 46% of the estimated injuries, and 5 types of items–gate, door, or fence; toy; bed, mat, blanket, or pillow; urine; and bowl or dish–accounted for almost three-quarters of the estimated injuries. Healthcare providers and other organizations may want to focus injury prevention activities on these types of items.

Dog-item-related falls affecting the lower extremity increased with patient age, with over 30% of the falls involving patients aged 60 years or older. Over three-quarters of the patients were female. This demographic pattern was like that found for dog-related falls affecting the lower extremity.[11] Moreover, a prior study of

dog-related falls reported 68% of the patients to be female and 24% aged 65 years or older,[3] and other studies of dog-leash related injuries also observed the majority of patients to be female and 15–32% aged 60 years or older.[4,8,9,12] Females and older adults may be at particular risk of dog-item-related falls.

The most common injury type (diagnosis) in dog-item-related falls affecting the lower extremity was strain or sprain followed by fracture, contusion or abrasion, and laceration, a pattern similar to that observed for dog-related falls affecting the lower extremity.[11] Most such injuries might not be expected to require extensive hospital intervention. This is consistent with the observation that 89% of the patients were treated or evaluated and released from the hospital ED. However, it should be noted that over 10% of the patients were treated and admitted within the same hospital or transferred to another hospital.

The results of this study suggests ways to reduce the risk of dog-item-related falls. Care should be taken when around dog items, particularly dog gates, doors, or fences; toys; beds, mats, blankets, or pillows; urine; and bowls or dishes. Effort should be made to train the dog to only urinate outside or in a particular place inside, such as on pee pads. If the dog urinates on the floor, it should cleaned up as soon as possible.

There are limitations to this study. NEISS collects data on consumer product- and activity-related injuries treated at US hospital EDs. Thus, dog items might be expected to meet NEISS inclusion criteria; the NEISS database even has a product code for pet supplies. In fact, the NEISS database has been used for previous dog-item-related injury investigations.[4,7-10] However, certain items, such as dog urine and feces might not fit into this inclusion criteria; as such, some dog items might only be incidentally reported to NEISS.

In addition, dog-item-related falls involving injuries were first identified by searching the record Narrative field for specific letter groups. If the Narrative field for a record of a dog-item-related fall injury did not include these letter groups, it would not be included in the study. Moreover, the further selection of records to be included in the study and the sorting of them into the various dog items was performed by a single person and was based on the Narrative field, which contains a limited amount of information. Errors in the selection and classification of records may have resulted in records being included or excluded erroneously or misclassified. Finally, only those dog-item-related falls affecting the lower extremity treated at hospital EDs were included in the study. The number of such injuries not seen at EDs is unknown.

In conclusion, the estimated number of dog-item-related falls affecting the lower extremity and treated at US hospital EDs has increased over the last 24 years. The majority of these injuries were due to dog gates, doors, or fences; toys; beds, mats, blankets, or pillows; urine; and bowls or dishes. Over three-quarters of the patients were female, and over 30% of patients were aged 60 years or older. The most frequently reported injuries were strain or sprain, fracture, and contusion or abrasion. Most patients were treated or evaluated at the ED and released. The information in this study may be useful for healthcare providers and others to identify those individuals most at risk for such injuries and to create plans to manage and prevent these injuries.

Mathias B. Forrester, BS, is an independent researcher in Austin, Texas. Now retired, he previously performed public health research for various university and government programs for 38 years.

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Top 3 Recommended Therapies for KOA: Knee Orthoses, Hydrotherapy, Exercise

By Xiao Chen, Yuanhe Fan, Hongliang Tu, and Yuan Luo

Assessing the clinical efficacy of different therapeutic options for KOA will aid clinicians in treating patients.

While clinicians recognize the positive role of physical therapy in improving symptoms and functionality in knee osteoarthritis (KOA) patients, these methods may differ in mechanisms of action, applicability, and efficacy variances. Thus, the aim of this study was to assess and compare the clinical efficacy of various therapeutic options in treating patients with KOA.

Methods

The authors performed a comprehensive search of PubMed, Embase, OVID, Cochrane Library, and Web of Science databases from their inception to December 10, 2023, identifying randomized controlled trials (RCTs) examining the effects of therapeutic options on KOA. Two researchers independently performed literature screening, data extraction, data collection and organization, and quality assessment. The data obtained were subjected to statistical analysis and graphical representation using Stata 17.0 software.

Results

In total, 139 RCTs encompassing 9,644 KOA patients and involving 12 therapeutic options were included: low level laser therapy (LLLT), high intensity laser therapy (HILT), transcutaneous electrical nerve stimulation (TENS), interferential current (IFC), short wave diathermy, ultrasound, lateral wedged insole, knee orthoses, exercise, hydrotherapy, kinesio taping (KT), and extracorporeal shock wave therapy (ESWT). Per the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain score, knee orthoses were determined to be the most likely to yield the best results, followed by exercise and HILT. In terms of WOMAC function score, knee orthoses emerged as the technique with the highest likelihood of being optimal, followed by hydrotherapy and ESWT. Knee orthoses ranked highest in effectiveness concerning the WOMAC stiffness score, followed by exercise and hydrotherapy. For the total WOMAC score, hydrotherapy demonstrated the highest probability of being the best technique, followed by exercise and HILT. Regarding the visual analog scale (VAS)-rest, hydrotherapy exhibited the greatest likelihood of being the optimum technique, followed by HILT and LLLT. In terms of VAS-activity, knee orthoses had the highest probability of being the best technique, followed by LLLT and exercise. Overall, knee orthoses had the highest probability of being the best technique, followed by hydrotherapy and exercise. (Figure.)

Discussion

Overall, knee orthoses provide the most effective treatment for KOA by (1) improving joint biomechanics by adjusting the knee joint's force line to evenly distribute load and reduce excessive stress on cartilage and soft tissues; (2) enhancing joint stability by limiting excessive knee movement in unstable conditions, thereby reducing injury risk and pain; (3) alleviating muscle fatigue by supporting surrounding muscles and reducing their workload to maintain joint function; (4) adjusting proprioception to improve patients' awareness of knee joint position and movement, enhancing joint control; and (5) reducing the inflammatory response by limiting inflammation spread and easing related symptoms.

For pain reduction, this study demonstrates

This article has been excerpted from "Clinical efficacy of different therapeutic options for knee osteoarthritis: A network meta-analysis based on randomized clinical trials." PLOS ONE 20(6): e0324864. https://doi.org/10.1371/journal.pone.0324864. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity. Use is per CC-BY 4.0 International.

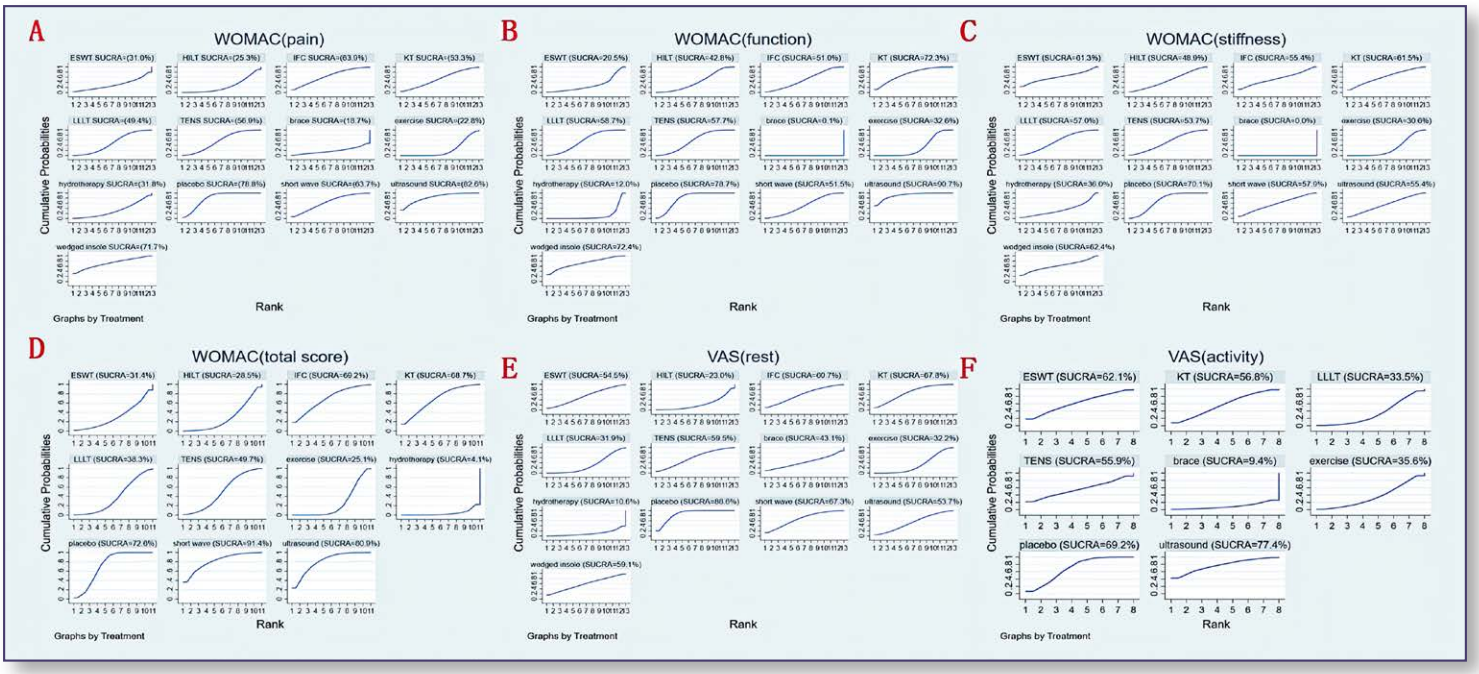

Figure. Surface under the cumulative ranking (SUCRA) for (A) WOMAC pain score, (B) WOMAC function score, (C) WOMAC stiffness score, (D) total WOMAC score, (E) VAS-rest and (F) VAS-activity at last follow-up.

that aquatic therapy is particularly effective and low impact. Evidence has shown that this therapy, which can involve exercise in water or the use of water's properties for treatment, significantly reduces pain and enhances physical function through heat stimulation and buoyancy. Increased water depth provides greater buoyancy, unloading the joints and consequently easing the pain associated with KOA.

This study reveals that HILT, in terms of overall efficacy, is surpassed only by knee orthoses, hydrotherapy, and exercise therapy. In terms of pain alleviation, the efficacy of both HILT and LLLT is secondary only to that of hydrotherapy. Clinically, LLLT has been shown to mitigate pain and inflammation, facilitate healing and tissue repair, and enhance blood circulation. HILT, providing concentrated laser energy over a brief period, penetrates deeper into tissues, eliciting a more potent biostimulative and anti-inflammatory response.

Substantial evidence supports the improvement of KOA symptoms, including pain, functionality, and quality of life, through exercise intervention, with aerobic and mind-body exercises showing the most significant benefits for pain and function, while strengthening and flexibility/skill exercises are the next best options. A prior network meta-analysis conducted by Mo et al. investigated the clinical efficacy of 5 different exercise therapies for the management of KOA, including aquatic exercise (AE), stationary cycling (CY), resistance training (RT), traditional exercise (TC), and yoga (YG). The findings concluded that AE (for pain relief) and YG (for alleviating joint stiffness, improving knee function, and enhancing quality of life) are the most effective interventions, followed by RT, CY, and TC. This study considers various exercise therapies as a single intervention for comparison with other treatment modalities, indicating that exercise therapy is effective in improving knee joint function and warrants broader clinical application.

This study's conclusions align with prior findings indicating that while pulsed ultrasound is moderately effective for pain improvement, it does not significantly enhance other knee joint functions.

Wedge insoles, similar to knee orthoses, primarily aim to alleviate knee joint stress by modifying joint load. Clinically, lateral wedge insoles are predominantly utilized. However, studies indicate that they do not outperform neutral devices in pain reduction. The reduction of the knee adduction moment by only 5–6% may be insufficient for pain alleviation. Additionally, factors like the sagittal moment and muscle co-contraction might have a more profound impact on the medial knee load, suggesting that a decrease in the adduction moment alone is not adequate to improve KOA function and pain.

When evaluating overall treatment efficacy, emphasis is placed on the WOMAC score and the resting VAS pain score, as these assessments are nearly universally conducted in the literature, thus offering a more robust framework for both direct and indirect comparative analyses.

Conclusion

This study aimed to ascertain the comparative effects of various physical therapies for KOA, to aid clinicians in precisely selecting the most suitable physical therapy method based on individual patient conditions, enhancing treatment efficacy, reducing unnecessary medical resource wastage, and providing robust guidance and evidence for future research directions. The findings suggest that knee orthoses may be the most recommended therapeutic option for the KOA followed by hydrotherapy and exercise.

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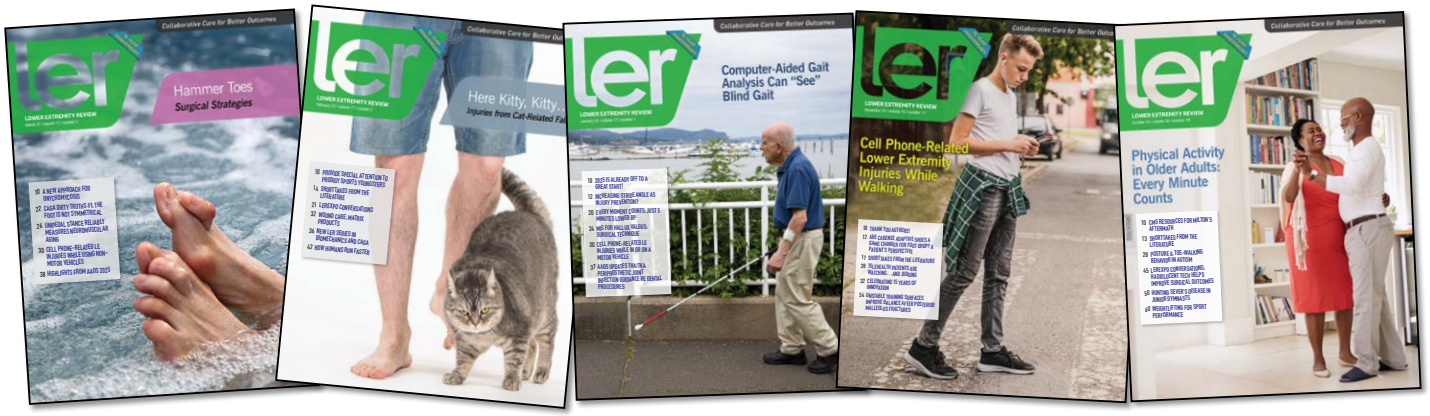

LOWER EXTREMITY REVIEW
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New & Noteworthy

Noteworthy products, association news, and market updates

MUSHROOM-BASED ROLL-ON FOR MUSCLE RELIEF

Xtreme Roll-On, part of the Xtreme Wellness product line, mixes a blend of reishi mushroom peptides with its proprietary BioHeat Matrix to help improve circulation to calm inflammation, and accelerate localized muscle relief in smaller/harder-to-reach areas. The BioHeat Matrix features capsicum frutescens ferment extract, a bioactive compound that gently warms tight, sore areas to restore mobility and promote faster recovery. Other ingredients include arnica (for tension or strain), turmeric oil (to promote circulation), bromelain (an enzyme to help reduce swelling/support tissue recovery), menthol, camphor, and a blend of botanical oils (willow bark, cinnamon leaf, sage, peppermint). Ideal for daily use at work, after workouts, or on the go, the roll-on format allows hands-free application with no strong odor or sticky residue. Formulated for use multiple times per day. New doctors receive a 10% discount on our exclusive wholesale pricing and a free sample pack (limited supply) shipped right to your clinic.

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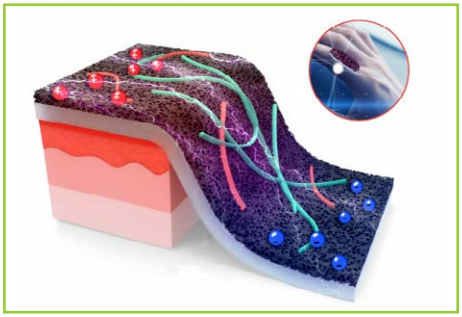
SMART SENSOR DEVELOPED TO MONITOR WOUNDS

Researchers from Pennsylvania State University (Penn State) and China's Hebei University of Technology aimed to accurately measure temperature and strain signals without crosstalk by using laser-induced graphene (LIG), a two-dimensional material. In doing so, they discovered that this material also has thermoelectric properties, said Huanyu "Larry" Cheng, James L. Henderson, Jr. memorial associate professor of engineering science and mechanics at Penn State, so it has the ability to convert temperature differences into electrical voltage and vice versa, enabling such materials to be used for applications like energy harvesting and temperature sensing. According to Cheng, this newly identified thermoelectric property of LIG makes it easy to separate the 2 sensor measurements and ideal for healthcare applications such as a sensor embedded in a bandage.



The flexible sensor, ideal for use in the human body, uses laser-induced graphene to simultaneously but separately measure temperature and strain, potentially enabling better wound healing monitoring by providing clearer insights into inflammation and recovery. Image courtesy of the researchers.

Cheng also noted that the sensor is highly sensitive, detecting temperature changes as small as 0.5 degrees Celsius. The material's design takes advantage of the way porous graphene and thermoelectric components work together, making it nearly 4 times better at converting heat into electricity. The sensor can also stretch up to 45%, as well as conform to different shapes and surfaces, without losing function. Additionally, since the thermoelectric aspect of LIG also means it can generate electrical power when there is a temperature difference, LIG sensors are self-powered. This could be particularly useful for continuous monitoring in clinical settings.

In addition to refining the sensor, the team is developing a wireless system that will allow people to monitor the data from the sensor remotely. This will make it possible to track important information, such as temperature or strain, in real time using smartphones or other devices.

VIRTUAL REALITY GAIT-TRAINING PLATFORM

GaitBetter is a state-of-the-art motor-cognitive virtual reality (VR) intervention for gait rehabilitation and fall prevention. It uses gamification and semi-immersive VR to simulate motor-cognitive challenges that patients experience in everyday life. Clinically proven to accelerate more positive outcomes and reduce falls by over 70%, this innovative solution enables clinicians to tailor therapy intensity and specificity to the unique needs of their patients. Harnessing artificial intelligence–based gait tracking, patients play a fun and safe "game" as they see their feet movements projected into a VR environment displayed on a TV screen in front

of them. Easily added to any treadmill, patients face virtual obstacles to improve gait while performing complex tasks requiring attention, memory, motor planning, and execution to enhance motor-cognitive skills.

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ULTRASONIC FOOT STIMULATION DEVICE DESIGNED TO IMPROVE CIRCULATION, PREVENT DIABETES COMPLICATIONS

To reduce the likelihood of consequences caused by impaired blood flow, scientists from Lithuania have developed an ultrasonic foot stimulation device that can non-invasively improve blood circulation in the lower limbs, with the aim of preventing diabetic foot. This innovative device was created through a collaborative effort of scientists from the Kaunas University of Technology (KTU) and the Lithuanian University of Health Sciences (LSMU).

The device uses particular piezoelectric elements to generate a broad spectrum of acoustic ultrasound waves in response to an electrical signal. Then, after selecting the appropriate parameters, the ultrasound is transmitted to the foot tissues and can stimulate blood flow in practically the entire leg. In this way, it is possible to regulate thrombogenesis, immune response, and inflammatory processes, which are essential for normal vascular and general tissue function. In addition, ultrasound waves can act on nerve structures, considering that all blood vessels have innervation and thus activate vascular tone in a vast tissue area.

The device's operation is non-contact and non-thermal, which minimizes possible adverse events. It can be tailored for individual use with appropriate software modifications, making it a valuable tool for patients with diabetes and other peripheral circulatory disorders. It also holds promise for older individuals with chronic vascular dysfunction.

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MICRONEEDLE TECHNOLOGIES MAY ACCELERATE DIABETIC WOUND HEALING

Researchers from the National University of Singapore (NUS) have developed 2 microneedle technologies that have shown efficacy in accelerating diabetic wound healing in preclinical models by preserving the functions of proteins called growth factors, and removing undesirable inflammatory compounds.

In the first approach, instead of delivering the growth factors directly, the team first increased the production of growth factors within the wound by developing sucralfate microneedles (SUC-MN) to deliver an important immunomodulatory protein, interleukin-4 (IL-4), to stimulate the production of growth factors in diabetic tissues. IL-4 helps to regulate the immune response and promote tissue regeneration, while sucralfate protects growth factors from degradation. The microneedles dissolve in the wound, delivering IL-4 and sucralfate directly to the wound. This localized delivery system minimizes systemic side effects and avoids secondary damage to delicate, newly formed tissues caused by traditional adhesive dressing that is currently used clinically. The researchers found that SUC-MN significantly accelerated wound healing twice as fast when compared to traditional treatments.

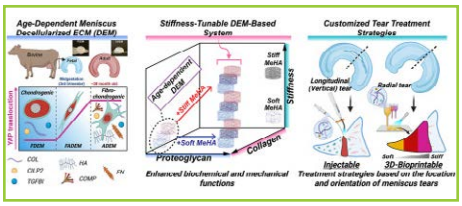
For the second approach, the team explored the use of microneedles to extract undesirable pro-inflammatory proteins and immune cells. To do so, the team needed to find a suitable coating material—they screened and then used heparin-coated porous microneedles (HPMN)—that could act as a sponge to soak

The microneedles were fabricated from poly lactic-co-glycolic acid (PLGA), an FDA-approved class of biodegradable polymers that are biocompatible and can be used in the sustained delivery of drugs and other molecules. The sponge-like PLGA microneedles, made using the moulds shown above, can help to alleviate inflammatory skin disorders.

up pro-inflammatory compounds, known as chemokines, which are 'messenger' molecules that recruit and trap pro-inflammatory immune cells called monocytes in wound tissues. Based on previous studies, heparin has been found to bind readily to chemokines. The team demonstrated that HPMN could effectively deplete chemokines and monocytes from the wound site, leading to a 50% reduction in tissue inflammation as well as a 90% reduction in wound size by the fourteenth day of treatment.

The development of SUC-MN and HPMN represents a significant step forward in the field of wound healing and skin disease management. The team intends to conduct further studies to explore the potential of this technology and bring it to market. For extractive microneedles in particular, the team will fabricate microneedles with more controllable pore sizes using advanced technologies, such as 3D printing, and integrate antibacterial properties into the microneedles as clinical non-healing wounds often accompany infections. They are also designing flexible microneedle patches to ensure that they fit well to various tissue shapes.

CUSTOMIZABLE HYDROGEL SHOWS PROMISE FOR TREATING MENISCUS INJURIES



Through creating a treatment adaptable to the different needs of patients—using a new 3D-printed hydrogel made from cow meniscus—researchers in the Perelman School of Medicine at the University of Pennsylvania (Penn) believe they may have unlocked a better fix no matter where an injury occurs in a meniscus. "We developed a hydrogel that can be adjusted based on the patient's age and the stiffness requirements of the injured tissue, which is important because the meniscus has different biochemical and biomechanical properties that vary depending upon the location in the tissue," said researcher Su Chin Heo, PhD, an assistant professor of Orthopaedic Surgery in the McKay Orthopaedic Research Lab at Penn.

The specialized hydrogel was developed by first extracting proteins from donor cow meniscus tissue. Those proteins then directed new cells to become the right types of repair cells for the damaged meniscus and were used as the basis for the treatment's structures. To prevent rejection, the team removed cellular components from the cow tissue while preserving its structural framework. To further customize the hydrogels, Heo and his fellow researchers used 3D-printing techniques to account for the variation in the meniscus tissue. That way, they could more closely match the tissue in the areas they were trying to repair.

"In our animal studies, we've seen the hydrogel integrate well with the surrounding tissue, potentially offering patients a more complete recovery," said Se-Hwan Lee, PhD, a post-doctoral fellow in the McKay Lab. "It's a more precise, biologically matched solution. We believe this could outperform current treatments."

The team is now transitioning from small mammal studies to large animal models.

CIRCULAR FRAME HINGES FOR KNEE, ANKLE APPLICATIONS

Orthofix Medical's TrueLok™ Phantom and Tornado Hinges, from the company's Orthopedics TrueLok circular frame portfolio, are designed for use with TrueLok circular frame offerings, including the TrueLok EVO Ring Fixation System. The TrueLok EVO System is a circular ring construct that consists of both radiolucent rings and struts for clearer visualization of the bone under Xray while also providing a lightweight frame for patient comfort. The TrueLok Phantom Hinge allows surgeons to achieve precise alignment when performing joint distraction or contracture correction procedures by maintaining the axis of rotation and joint mobility. The TrueLok Tornado Hinge features a flexible spring-like design that enables the natural joint motion to be restored following a joint distraction procedure. The Phantom Hinges and the Tornado Hinges are both for use in ankle and knee applications and sterile packaged for quick and easy use.

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AI TOOL BETTER ASSESS PARKINSON'S DISEASE, OTHER MOVEMENT DISORDERS

Diego Guarin, PhD, an assistant professor of applied physiology and kinesiology in the University of Florida's College of Health and Human Performance has developed an open-source computer program that uses artificial intelligence (AI) to analyze videos of patients with Parkinson's disease and other movement disorders, thereby addressing the potential risk of inconsistency and subjectivity in traditional clinical assessments. The tool, called VisionMD, helps doctors more accurately monitor subtle motor changes, improving patient care and advancing clinical research. VisionMD analyzes standard videos—whether recorded on a smartphone, laptop, or over Zoom—and automatically extracts precise motion metrics. The software runs entirely on local computers, ensuring data privacy.

Florian Lange, a neurologist at University Hospital Würzburg, Germany, and Martin Reich, a neuroimaging professor at University of Würzburg, Germany, adapted VisionMD to

help them optimize treatment for patients with tremor, particularly those using deep brain stimulation (DBS) implants.

"A big challenge with many aspects of medicine today is how difficult it is to get objective data, especially with movement disorders like Parkinson's disease or tremor," Lange said. "If…[we] watched the same video of a patient, we might rate the severity at…different levels. But the software gives us precise, unbiased data." By recording videos of patients at a variety of stimulator settings, the software identifies which DBS configuration offers the best symptom relief.

As open-source software, the program is freely available to improve and customize. The team is also working to expand the tool's capabilities by adding more motor assessment tasks frequently used in clinical settings. Early adopters say VisionMD's accessibility and ease of use have the potential to transform movement disorder research and care.

To access VisionMD, go to https://mealab.github.io/VisionMD-Tutorial/.

SMART BOOTS FOR DFU TREATMENT

The Foot Defender+ powered by Sensoria is designed to help heal diabetic foot ulcers (DFUs) and reduce the risk of amputations for extended quality of life. The solution combines the Foot Defender Smart Boot with Sensoria Core microelectronics and the Sensoria Patient Mobile App and Clinician Dashboard to monitor a patient's DFU healing and rehabilitation compliance to the clinician's prescribed stabilization and mechanical offloading protocol. This device has an easy-to-use shoe-like design with a low-profile, abrasion-resistant, compression-molded outsole that alleviates average contact pressure across the foot by up to 50% as compared to other protective boots on the market. Used for both stabilization and offloading, the boot is non-intrusive, cost-effective, and readily usable or embeddable and deployable for a broad spectrum of devices and patient types, whether they are bed-bound, chair-bound, or ambulatory.

Defender
305/204-7203
footdefender.com

ORTHOSIS FOR TREATMENT OF SHIN SPLINTS

Invented by former elite athletes turned medical doctor, biomedical engineer, and product designer, the Solushin® orthosis is designed to treat medial tibial stress syndrome (shin splints). Designed to be worn before or after running, for 30 minutes to 2 hours, it works by compressing the area of pain and inflammation and reducing tension in the soleus with patented counter-traction technology. The user can expect a reduction in pain and release of tension in their calves in the short term. Over a more extended period, the sufferer can expect to return to running with no pain with consistent use. This is typically 5 weeks, as reflected in the clinical trial. It is recommended that the Solushin® be used as an adjunct therapy to strengthening exercises and load-management programs provided by a healthcare professional.

Solushin
solushin.com

MINIMALLY INVASIVE BUNION FIXATION SYSTEM

Stryker's PROstep MIS Lapidus fixation system is designed to treat bunions using a minimally invasive surgical reduction, while providing faster recovery. It uses the hallux valgus deformity and subsequent fusion of the first metatarsal cuneiform joint. The technology features MIS joint preparation, triplanar reduction, and a 3-screw construct that creates a tension band for biomechanical stability. The company highlights benefits including a 2.5% decrease in recurrence compared to open lapidus procedures, a 9% reduction in non-union rates as a result of MIS lapidus joint preparation, and a 76% reduction in scar size compared to open bunion correction.

Stryker
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Muscle Activity in Soccer Players with a History of Hamstring Strain Injuries

Reference: Ohtsubo et al. JSSM 2024

Designed by @YLMSportScience

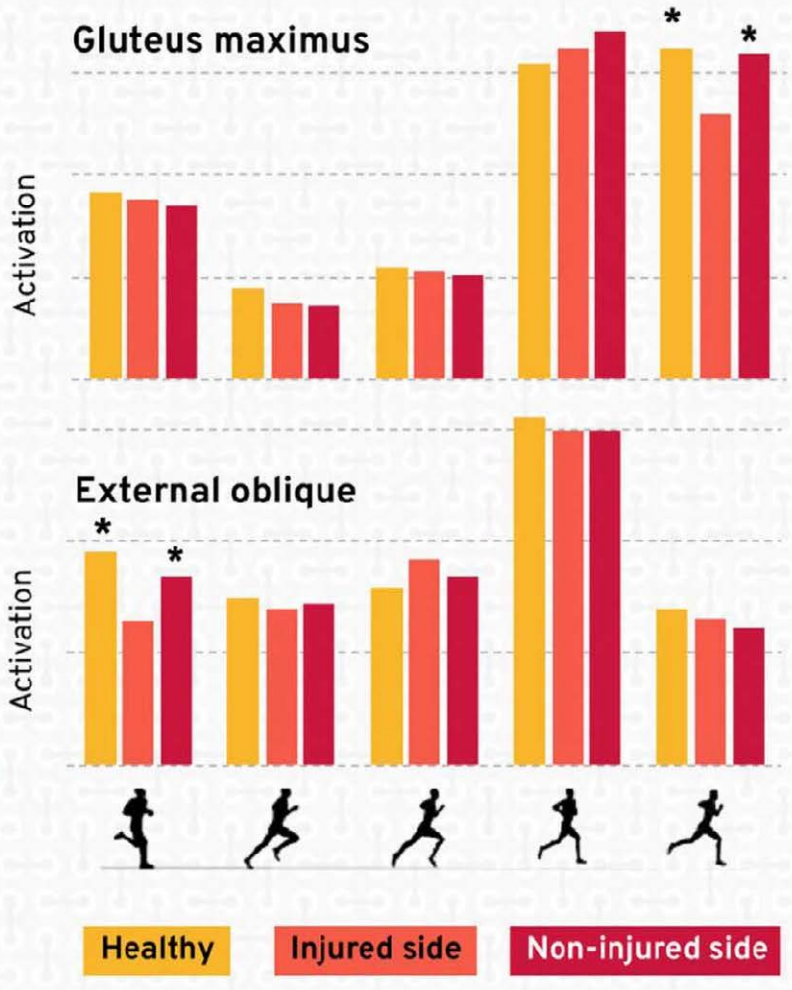
KINESPORT

26 male soccer players of which 13 with and 13 without hamstring strain injury history completed a maximal 30-m sprint.

RESULTS

A lower activity in the muscles contributing to trunk instability (especially external oblique muscle and gluteus maximus) was observed in players with hamstring strain injury history, before and after ground impact during accelerated sprinting, compared to the healthy group.

Images provided by PresenterMedia



Rehabilitation programs that include progressive agility and core stabilization exercises therefore appear to be appropriate after hamstring injuries.

Source: Ohtsubo R, Saito H, Hirose N. Characterizing Muscle Activity in Soccer Players with a History of Hamstring Strain Injuries during Accelerated Sprinting. Journal of Sports Science and Medicine. 2024;23(1);656 - 662. https://doi.org/10.52082/jssm.2024.656

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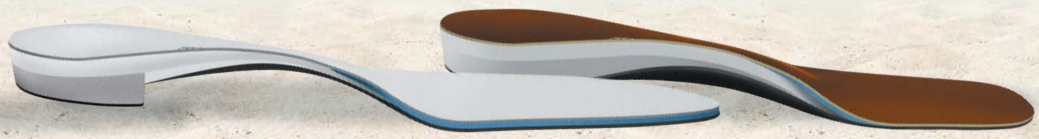

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