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LOWER EXTREMITY REVIEW

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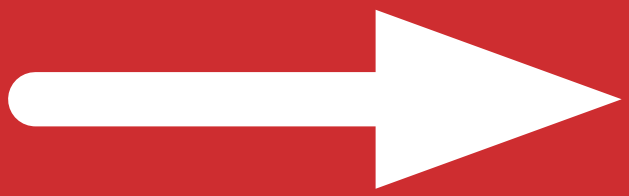

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15 Celebrating 15 Years of Healthcare Innovations

11 Readers offer their thoughts on the greatest innovations of the last 15 years.

The dictionary defines innovation as the introduction or use of new ideas or ways of doing things. But it's really much more than that:

- In *What Customers Want*, innovation expert Anthony Ulwick wrote, "Innovation is not the result of thinking differently. It is the result of thinking deliberately (in specific ways) about existing problems and unmet needs."
- Others have added that innovation is a corporate mindset of continuous quality improvement that encourages improving processes or revising products in response to customer needs.

As part of LER's 15th anniversary celebration, we asked readers to weigh in on the many facets of innovation that have helped improve patient outcomes in lower extremity care. Here, we share some of their thoughts.

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We couldn't do what we do at *Lower Extremity Review* without the countless authors, reviewers, Editorial Advisory Board members, and readers who provide input on a daily basis. For all of that, we are thankful.

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Lower Extremity Review

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

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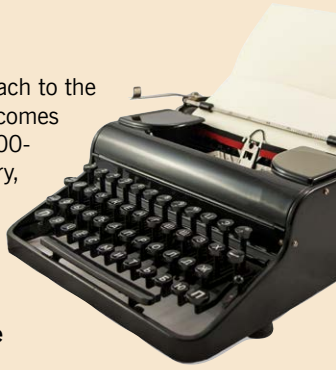

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Editorial **Observations**

Thank You Authors, Reviewers, Readers

By Janice T. Radak, Editor

Innovation comes in many flavors and knocks on your door in many ways. Sometimes it looks like a great idea, and other times, you want to slam that door immediately. But then, you often want to take a peak.

That's true for some of our readers who took the challenge to write on what they thought the greatest innovation has been over the last 15 years. Why 15 years? Because that's how long ***LER*** has been around, and we wanted to take the opportunity to look back and see how far we've come. The thoughts shared in the collage, "Celebrating 15 Years of Innovation," which appears here/page 32, provides details on a variety of innovations that affect everyday practice, but other articles within the issue have been specially curated to address this topic as well. We hope you enjoy them all.

Of course, the innovations that ***LER*** brings every month are the products of our many authors and reviewers and we want to provide a full-throated shout out to them for their efforts. We couldn't do it without them and we thank you.

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Cadense Adaptive Shoes: Are They a Game Changer for People with Foot Drop and CMT Disorder?

By Lainie Ishbia, MSW

Most people don't have to think about walking—they just walk. But for those of us living with foot drop, walking requires focus because we know from experience how just 1 distracted step can quickly manifest into a painful fall.

Foot Drop 101

Foot drop, also known as drop foot, is a condition characterized by difficulty or inability to lift the front part of the foot. It is typically caused by weakness or paralysis of the muscles responsible for lifting the foot, often due to nerve damage or injury.

Walking with foot drop involves lifting your foot high enough to avoid dragging it—kind of like maneuvering an over-packed, stubborn suitcase over a curb, with the same end goal of remaining upright and not tipping over.

Everyday life with foot drop can be incredibly challenging and exhausting—trust me, I know!

Back in my twenties, fresh out of grad school and pre bilateral leg braces, I was navigating the bustling streets of Chicago. I can't count the number of times I ended up with skinned knees from tripping over what seemed like thin air. Nothing says "young professional" quite like having to duck into a restroom to clean up bloody knees before a meeting!

So, here's where a new shoe brand steps in. Or, perhaps more aptly, slides in…

Cadense, according to their own description, "is a revolutionary company founded by Dr. Tyler Susko, driven by a vision to help those in need." They claim to have created "the world's first truly adaptive shoe."

The brand's signature shoe, named the Cadense Original, was designed specifically for people with various walking conditions.

On the short list of walking conditions, they say their shoes can help with – foot drop and neuropathy. Ummm, seriously?

While perusing their website, I stumbled upon the line (pun intended), "If you (or a loved one) struggle to lift your foot while swinging it forward or worry about tripping and falling, this shoe is made for you."

What? I immediately wrote to the company and asked to try them out! I couldn't press "send" fast enough, as I needed to see if their shoes could really help to improve the lives of those living with foot drop.

Honestly, this wasn't so much for myself (My foot drop is mostly corrected by my bilateral AFOs), but more for my eldest child Will, who inherited Charcot-Marie-Tooth (CMT) disease and foot drop from me, and for all the members of my Trend-Able community living with foot drop.

Cadense answered my email and agreed to send me a pair of shoes in exchange for me making and posting a few Instagram Reels showing me walking in their shoes and giving my testimonial. I agreed, but only on the condition that I could test the shoes for a few weeks first. If they didn't prove helpful, I told them I would return them. We had an agreement!

To provide an accurate assessment from someone without the built-in support of leg braces, I asked Cadense if they'd be willing to send a pair to my out-of-state adult child—chutzpah, I know! They said no!

So, given their 30-day return/refund policy, I decided to purchase a pair for Will to try on my own. Will is a young professional living in St. Paul, Minnesota, who has to travel and walk a lot for his job, which involves visiting college campuses across the US. Cha-ching! Order placed!

After receiving Cadense's signature "Orig-

Cadense Original, Black. *Image courtesy of Cadense Shoes.*

inal" shoes, both Will and I put them to the test. What follows are the opinions of myself, a full-time AFO wearer, and Will, my 23-year-old child who navigates his busy city life with mild to moderate foot drop and no AFOs.

A Word About Cadense's Shoe Sizing

Let's first talk about Cadense's shoe sizing.

Although my actual foot size is 7 1⁄2 or 8, I typically wear a size 8 1⁄2 wide after removing a shoe's insoles (which can be done with Cadense's sneakers) to accommodate my leg braces. However, Cadense doesn't offer half sizes in their wide-width shoes, so I ordered a size 8 wide. Even after removing the insoles, they were a bit too snug, so I exchanged them for a size 9 wide—perfect fit!

When ordering for my child, I was pleasantly surprised to find that Cadense not only offers half sizes in their regular widths but also carries the elusive 5½ adult size we needed. Cha-ching! Order placed!

Our First Impressions: Style and Design

When it comes to looks, Cadense doesn't disappoint. Both Will and I opted for the black version with its eye-catching striped sole. They could easily be mistaken for high-end non-adaptive sneaker styles like On Cloud and Hoka.

Will and I were both pleasantly surprised by how lightweight they are and how incredibly comfortable they feel on the feet.

The standout feature? The cleverly disguised Velcro closure. At first glance, these appear to be lace-up shoes, but they're actually slip-ons. The discreet Velcro is a game-changer for those of us who struggle with laces. It's a perfect blend of function and fashion.

What Sets The Cadense Original Sneaker Apart

Now, let's chat about what really makes the new Cadense brand of shoes unique.

For those of us with foot drop, we know that feeling when our foot feels like it's made of lead, especially after a long day.

Well, Cadense's shoes have 2 nylon pucks (small raised areas that glide) on the front part of the sole that are designed to help your foot glide forward when you're too tired to lift it. Since these pucks allow your foot to glide over surfaces, they can potentially help reduce the chances of you tripping as well.

But wait, there's more! (I feel like an infomercial host). Our Cadense adaptive shoes have what's called "variable friction" technology. This tech allows you to slide your foot forward when it's dragging, but also gives you enough grip to stop and push off when you want to.

Basically, by putting pressure down on the front part of the shoe (which is especially necessary when going from seated to standing), the pucks retract into the sole's foam and no longer slide – giving you a bit more stability and making each step feel smoother.

It's an interesting feature that's intended to adapt to your movement, even when your foot feels heavy and uncooperative. Pretty cool, right?

Are Cadense Shoes Helpful For People With Foot Drop?

Let's dive into this from 2 perspectives: mine as a full-time and very active bi-lateral AFO (leg brace) wearer, and Will's, as a busy young adult living with foot drop who does not wear AFOs.

From my AFO-wearing standpoint, I did not notice a dramatic difference in my walking or stability wearing my Cadense shoes. But here's the thing – my AFOs are supposed to be doing the heavy lifting when it comes to managing my foot drop.

So, while I really like my Cadense shoes,

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Pros & Cons of Cadense's Adaptive Shoes

Pros	Cons
• The Cadense sneaker is super stylish and looks like any other brand of high-end sneakers. You wouldn't know from looking at them that they are "adaptive".	• Heads up! Will found them to be a bit noisy when he walked on non-carpeted surfaces.
• The discreet Velcro closure and wide opening makes them super easy to slip on and off.	• If you're already rocking AFOs that work properly, you might not notice a huge difference in your mobility.
• They're extremely comfy, lightweight, and won't weigh you down. They're like walking on clouds… well, adaptive clouds.	• You definitely need to practice wearing them on different surfaces and be mindful when going from a sitting position to standing.
• Cadense sneakers are available in regular and wide width sizes and have removable insoles.	• While not outrageously priced for quality sneakers that could possibly change your life, they're definitely an investment.
• Cadense provides customers with fabulous tutorial videos and support emails for following your purchase.	
• Cadense's clever and innovative tech may make walking easier for many people living with foot drop and other walking conditions.	

wearing them wasn't a night-and-day change for me and my mobility.

That said, I find them to be super comfortable to wear and finding cute and lightweight sneakers that slip on easily with discreet Velcro is worth the price tag. And let's be real, most sneakers these days without any adaptive tech aren't exactly cheap!

But here's an unexpected bonus I discovered: As someone with 2 completely fused ankles, I found that I could actually slide my foot in and out while doing various exercises at the gym. This is normally impossible since my ankles don't turn at all. Check out our Instagram and Facebook pages where I posted videos of me walking and exercising in them.

Now, for the real kicker (sorry, couldn't resist) – My son Will, who doesn't wear leg braces, found his Cadense shoes to be nothing short of amazing! He believes that they genuinely help with his foot drop – especially when he's tired after having walked a lot around the city of St. Paul, Minnesota, and while traveling for his job.

So, while my AFO-wearing self might not be the best judge of the foot drop assistance, it seems like Cadense's adaptive shoes could be a game-changer for those managing foot drop without braces. Plus, they're stylish enough that you won't feel like you're wearing "special" shoes. Win-win, right?

Conclusion: Pros & Cons of Cadense's Adaptive Shoes

The table above provides a quick rundown of the "good" and the "meh" of Cadense's Original Adaptive shoes for people with foot drop.

The Bottom Line

If you're living with foot drop and feeling like you're dragging a stubborn suitcase around, Cadense shoes might be worth checking out. They're not miracle workers (wouldn't that be nice?) but they're an interesting attempt at making our daily obstacle course (aka life) a little easier to navigate. Remember, what works for one person might not work for another.

So, if you're in the market for some new kicks that might give you a little extra help, why not give Cadense a try? At the very least, you'll have some stylish sneakers that are easy to slip on. And who knows? They might just help you walk a little more comfortably and confidently. And couldn't we all use a bit more of that? ler

Lainie Ishbia is a TEDx Speaker, Writer, Adaptive Fashion Consultant, and Disability Advocate. She is the founder of Trend-Able (trend-able.com), a lifestyle and fashion brand that provides adaptive solutions for people who wear AFOs and live with disabilities. Lainie is also the co-creator of the Embrace It Podcast and Workshop Series, where she partners with various organizations to promote disability awareness and inclusion in the workplace.

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SMARTPHONE USAGE NEGATIVELY IMPACTS STANDING POSTURAL BALANCE

Researchers from Arizona State University and Carnegie Mellon University have found that modern smartphone usage can negatively impact standing postural balance—and that impact varies by the type of ground condition.

They had 16 healthy young individuals perform 2 tasks on their smartphones while standing on 4 different types of ground surfaces: rigid, foam-based compliant, robot-stimulated, and robot-stimulated oscillatory. They measured center-of-pressure (CoP) in each foot via force plates and then calculated net CoP. Temporal, spatial, and control aspects of postural balance were analyzed by virtual time-to-contact (VTC, a relatively new approach for investigating postural balance control), CoP path length (PL) and sway area (SA), and switching rate (SR), respectively. Two-way repeated measures analysis of variance (ANOVA) tests were performed for each dependent variable to compare the mean differences between smartphone tasks and ground conditions and their interaction effect.

They found that during smartphone usage, VTC decreased significantly while CoP, PL, and SA increased significantly.

They concluded that their results identify the potential fall risks of smartphone usage related to standing balance. The said these findings open the door for assistive devices and mobile phone technologies to prevent falls and mitigate their negative outcomes.

Source: *Noll WP, Phan V, Lee H. Modern smartphone usage can negatively impact postural balance while standing on dynamically challenging grounds. Gait Posture. 2024;107:233-239. doi: 10.1016/j.gaitpost.2023.10.010.*

DOES TEXTING WHILE WALKING AFFECT GAIT'S PLANTAR PRESSURE PARAMETERS?

This study aims to examine the possible effects of mobile phone use on plantar pressure and spatiotemporal parameters during walking.

Materials and methods: Thirty volunteers (18 males and 12 females) participated in the study. A 10-m walking path was prepared, and a messaging connection was established. Volunteers were asked to write 3 posts without word or character mistakes and to walk on the path as much as they wanted to make sure they were walking at their own pace. The gait's spatiotemporal parameters and plantar pressure parameters were recorded while walking. A paired samples t-test was used to determine whether there was a difference between normal walking and walking while texting.

Results: While walking and writing a message, cadence, speed, and step length decreased significantly ($P < 0.05$; Table 2). In the plantar pressure parameters, the fore- and midfoot load and pressure were significantly increased ($P < 0.05$; Table 3).

Table 2: Comparison of spatiotemporal parameters between texting gait and normal gait

Parameters	Normal gait Mean-SD	Texting gait Mean-SD	*P*
Time	12.92-1.66	13.83-1,64	0.005*
Cadence (step/min)	111.69-9.55	99.96-11.79	0.000*
Velocity (m/sec)	1.31-0.16	1.06-0.17	0.000*
L-Stride (m/step)	82.86-8.01	73,82-7.34	0.000*
R-Stride (m/step)	82.58-7.82	72.82-8.68	0.000*
L-Propulsion (m/s²)	8.20-1.44	6.25-1.55	0.000*
R-Propulsion (m/sec²)	8.07-1.62	6.34-1.18	0.000*
L-PelvicTilt (degree)	4.42-1.29	3.93-0.95	0.007*
R-PelvicTilt (degree)	4.63-1.29	4.03-0.96	0.003*
L-PelvicRot (degree)	12.59-5.01	9.31-3.21	0.000*
R-PelvicRot (degree)	12.69-4.74	8.87-3.11	0.000*

SD=Standard deviation, Paired sample *t*-test, *: $P<0.05$, PelvicRot: Pelvic rotation angle

Table 3: Comparison of plantar pressure parameters between texting gait and normal gait

Parameters	Normal gait Mean-SD	Texting gait Mean-SD	*P*
FFF (N)	1133.55-292.64	1206.31-255.96	0.033*
FMF (N)	192.44-118.92	244.74-141.86	0.041*
FRF (N)	817.83-238.72	778.92-192.99	0.123
PFF (N/cm²)	14.42-2.51	16.51-2.99	0.000*
PMF (N/cm²)	7.67-3.20	10.22-5.12	0.004*
PRF (N/cm²)	23.08-3.73	22.54-4.41	0.496

SD=Standard deviation, Paired sample *t*-test, *: $P<0.05$, FFF=Forefoot force, FMF=Midfoot force, FRF=Rearfoot force, PFF=Forefoot pressure, PMF=Midfoot pressure, PRF=Rearfoot pressure

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Continued from page 17

Conclusions: Compared to normal walking, the forces on the forefoot and midfoot and the pressure per unit area increased in walking while texting. It is thought that the pace of walking slows down, and focus and attention shift to the front of the body. ler

Source: *Elvan A, Ozer MT. Does Texting While Walking Affect Gait's Plantar Pressure Parameters? Niger J Clin Pract. 2024;27(3):325-329. doi: 10.4103/njcp.njcp_358_23. Use is per Creative Commons License.*

AEROBIC EXERCISE BOOSTS MUSCLE REGENERATION IN AGED MICE

Aerobic exercise effectively reverses the decline in endurance capacity and mitigates muscle atrophy in aged mice. It inhibits CCN2 secretion from senescent muscle stem cells, thereby enhancing skeletal muscle regeneration and preventing fibrosis in aged mice. AICAR supplementation mimics the beneficial effects of aerobic exercise. ler

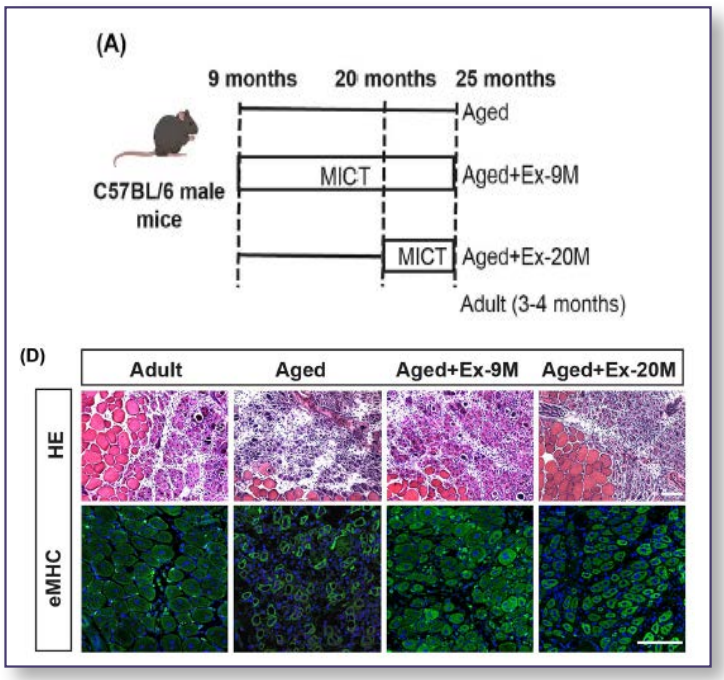

Figure. Aerobic exercise enhances skeletal muscle regeneration in aged mice. (A) C57BL/6 male mice were categorized into 4 groups: MICT initiated at 9 months old (aged + Ex-9M), MICT initiated at 20 months old (aged + Ex-20M), and controls for adult (3- to 4-month-old) and aged (25-month-old) mice. (D) Evaluation of muscle regeneration in tibialis anterior muscles at 6 dpi. Representative haematoxylin and eosin (H&E) and embryonic myosin heavy chain (eMHC) stained tibialis anterior tissue sections for adult, aged, aged + Ex-9M, and aged + Ex-20M mice. Scale bar, 100 μm.

Source: *Li F, Zhang F, Shi H, Xia H, Wei X, Liu S, Wu T, Li Y, Shu F, Chen M, Li J, Duan R. Aerobic exercise suppresses CCN2 secretion from senescent muscle stem cells and boosts muscle regeneration in aged mice. J Cachexia Sarcopenia Muscle. 2024;15(5):1733-1749. doi: 10.1002/jcsm.13526.*

CAN THERMOGRAPHY PREDICT DIABETIC FOOT ULCER RISK IN PATIENTS WITH DIABETES?

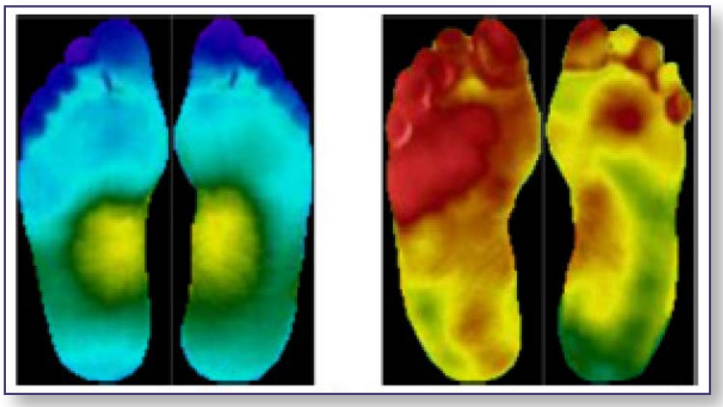

Figure. Symmetrical thermal distribution observed In a non-diabetic subject (left) and absent In a diabetic subject (right)

Image reprinted from Muralidhara S, Lucieri A, Dengel A, Ahmed S. Holistic multi-class classification & grading of diabetic foot ulcerations from plantar thermal images using deep learning. Health Inf Sci Syst. 2022;10(1):21. doi: 10.1007/s13755-022-00194-8. Use is per Creative Commons Attribution 4.0 International License.

Prevalence of diabetic foot ulcers (DFUs) in patients with diabetes mellitus (DM) is growing, and the use of thermography has sparked interest in this non-invasive diagnostic method for early DFU risk assessment and management.

The systematic review, conducted by an international research team, sought to explore the use of thermography to predict DFU risk in patients with DM. The research question was: "What is the ability of thermography to predict DFU risk in patients with DM?'

A systematic search of publications using MEDLINE, CINAHL, and Cochrane databases was conducted in April 2023, and relevant articles were reviewed. Data was extracted and a narrative synthesis was undertaken. The evidence-based librarianship (EBL) checklist assessed the methodological quality of the studies included and the team reviewed these articles against the primary and secondary outcomes of this review. The primary objective was to investigate the predictive capability of thermography in anticipating DFU risk among patients with DM. The secondary objective was to determine the usability and feasibility of thermography measurement.

Eight studies were conducted from 1994 to 2021 with an emphasis on the predictability of thermography in predicting DFU risk. All 8 studies focused on temperature variations associated with DFU development. Six of the included studies compared the effectiveness of DFU occurrence in diabetic patients and non-DFU use. The overall results showed that employing thermography in DFU prevention might allow for early detection and intervention, offering a non-invasive and effective means to reduce the risk of DFU development and its associated complications in patients with DM.

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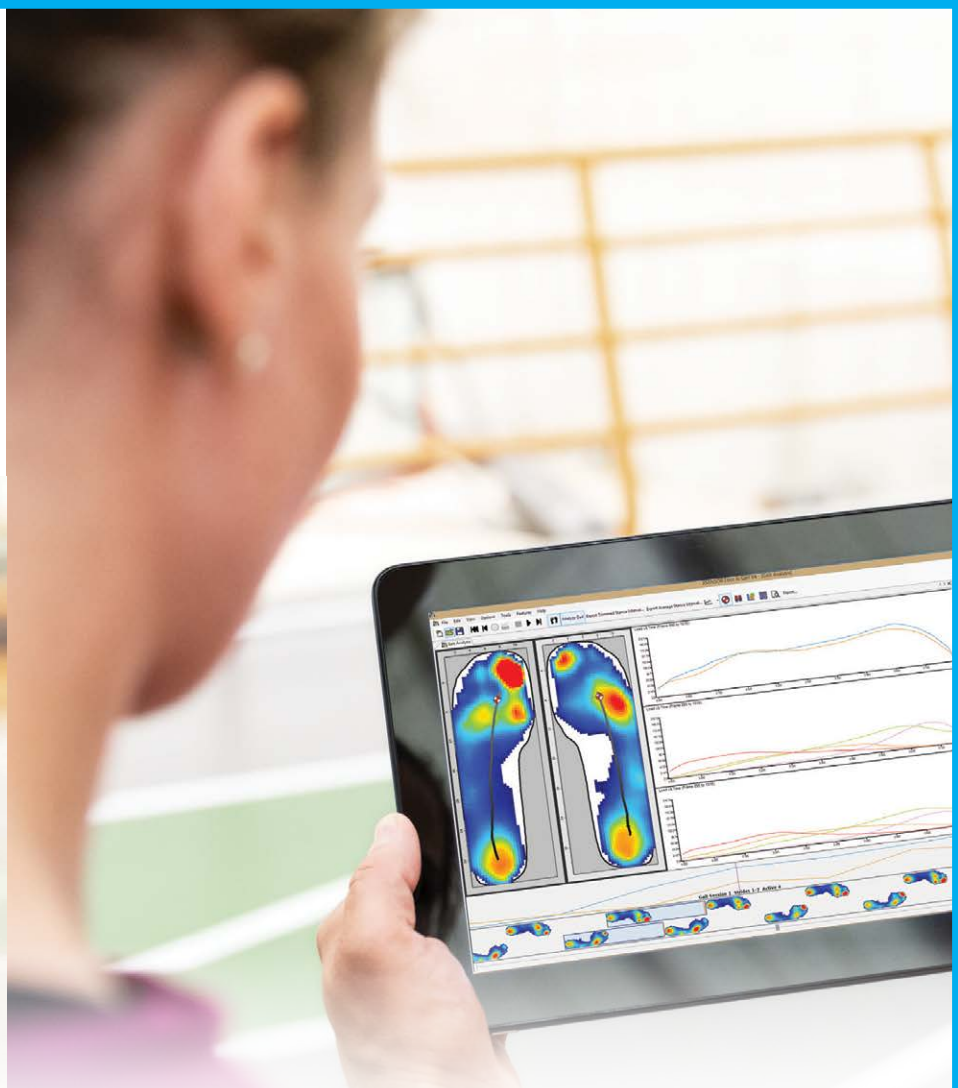

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Continued from page 18

In particular, the authors noted that among those with DFUs neuropathy is prevalent, leading to a loss of sensation in temperature and pain, hindering injury detection overall.

In conclusion, this systematic review highlights the role of thermography in DFU risk assessment and sets a clear path for future endeavors in this field. Integrating thermography into diabetes care could represent a crucial step in reducing the burden of DFUs and further advancing patient care in this population.

Source: *Thakku Sivakumar D, Murray B, Moore Z, Patton D, O'Connor T, Avsar P. Can thermography predict diabetic foot ulcer risk in patients with diabetes mellitus? A systematic review. J Tissue Viability. 2024 Jun 29:S0965-206X(24)00093-7. doi: 10.1016/j.jtv.2024.06.018.*

CAN A COMMON DEFINITION IMPROVE SURGICAL WOUND DEHISCENCE DIAGNOSIS?

Surgical wound dehiscence (SWD) can affect up to one-third of foot-related surgeries, making it a major complication and potential threat to patient outcomes. One key reason: delayed diagnosis, which has been attributed to varying definitions. In 2018, the World Union Wound Healing Societies (WUWHS) presented a consensus-based definition and classification for SWD in 2018 to address this issue, see Figure 1.

Definition: "Surgical wound dehiscence is the separation of the margins of a closed surgical incision that has been made in skin, with or without exposure or protrusion of underlying tissue, organs or implants. Separation may occur at single or multiple regions, or involve the full length of the incision, and may affect some or all tissue layers. A dehisced incision may, or may not, display clinical signs and symptoms of infection"

1	**Dermal layer only involved; no visible subcutaneous fat**
	No clinical signs and symptoms of infection
1a	As Grade 1 plus clinical signs and symptoms infection (e.g. superficial incisional SSI)
2	**Subcutaneous layer exposed; no fascia visible**
	No clinical signs and symptoms of infection
2a	As Grade 2 plus clinical signs and symptoms infection (e.g. superficial incisional SSI)
3	**Subcutaneous layer and fascia exposed**
	No clinical signs and symptoms of infection
3a	As Grade 3 plus clinical signs and symptoms infection (e.g. deep incisional SSI)
4	**Any area of fascial dehiscence with organ space, viscera, implant or bone exposed**
	No clinical signs and symptoms of infection
4a	As Grade 4 plus clinical signs and symptoms infection (e.g. organ/space SSI)

Surgical Wound Dehiscence Grading System, adapted from Consensus Document. Surgical wound dehiscence: improving prevention and outcomes. World Union Wound Healing Society, Wounds International. 2018

Figure 1: WUWHS SWD definition and grading system.[1]

Now, 2 new studies from an extended research team in the Netherlands have examined the uptake of this definition into clinical practice.

In the first, a scoping review of the literature, Muller-Sloof et al[1] examined 34 articles: 28 systematic reviews, 2 randomized clinical trials, 3 retrospective studies, and 1 book chapter; there was no restriction on year of publication. SWD was defined in different ways, such as "breakdown/disruption of the surgical wound" (n = 17), "separation/splitting apart of the wound edges" (n = 13), "gaping/re-opened wound" (n = 7), mechanical failure (n = 2), or infection (n = 1). Other studies defined SWD in relation to its depth (skin layers involved) or length over the incision, both complete and partial (n = 9). Only 1 study referenced the WUWHS definition. Further, they found that SWD continues to be (falsely) equivalent to surgical site infection (SSI). They note that SWD and SSI can occur simultaneously in the same wound and that dehisced wounds are not always infected, as infected wounds are not always dehisced.

These authors found a variety of definitions for SWD continued to be used, at least in the literature. They found little adoption of the WUWHS definition following its introduction in 2018 and concluded that uniform use of an unambiguous definition in clinical practice will improve the ability to correctly diagnose SWD independently of SSI. Proper differentiation between SWD and SSI is crucial for appropriate treatment decisions, including conservative care, surgical intervention, and, if necessary, antibiotics. They also write that the WUWHS classification provides criteria to identify SSI, which are in line with the Centers for Disease Control and Prevention guidelines for SSI diagnosis and that both are recommended for use in clinical practice in order to accurately differentiate between SWD and SSI.

In the second study,[2] the team used a quasi-experimental pretest-posttest format to investigate the inter-rater reliability among healthcare professionals (HCP) and wound care professionals (WCP) when assessing wound photos on the presence or absence of SWD before and after training on the WUWHS-definition.

Wound expert teams compiled a set of 20 photos (SWD+: 19; SWD−: 1) and a video training. Subsequently, 262 healthcare professionals received the pretest link to assess wound photos. After completion, participants received the posttest link, including a (video) training on the WUWHS-definition, and reassessment of 14 photos (SWD+: 13; SWD−: 1).

Primary outcomes included 1) pretest-posttest inter-rater-reliability among participants in assessing photos in congruence with the WUWHS-definition 2) the impact of training on assessment scores. Secondary outcome was familiarity with the WUWHS-definition.

They reported that 131 participants (65 HCPs, 66 WCPs) completed both tests. The posttest inter-rater reliability among participants for correctly identifying SWD was increased from 67.6% to 76.2%, reaching statistical significance (P-value: 0.001; 95 % Confidence Interval [1.8–2.2]). Sub-analyses per photo showed improved SWD posttest scores in 13 photos, while statistical significance was reached in 7 photos. Thirty-three percent of participants knew the WUWHS definition.

Because the definition provides diagnostic criteria for accurate SWD diagnosis, the group concluded that training on the WUWHS definition increased inter-rater reliability in correctly diagnosing surgical wound dehiscence. They encouraged widespread use of the definition as a means to improve uniformity in care for patients with SWD.

Sources *(Use is per CC BY 4.0)*

1. Muller-Sloof E, de Laat E, Zwanenburg P, et al. Exploring the definition of surgical wound dehiscence in literature: a scoping review.

Continued on page 22

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J Tissue Viability. 2024: https://doi.org/10.1016/j.jtv.2024.09.006. Eprint ahead of publication.

2. *Muller-Sloof E, de Laat E, Baljé-Volkers C, Hummelink S, Vermeulen H, Ulrich D. Inter-rater reliability among healthcare professionals in assessing postoperative wound photos for the presence or absence of surgical wound dehiscence: a pretest - posttest study. J Tissue Viability. 2024:S0965-206X(24)00106-2. doi: 10.1016/j.jtv.2024.07.001.*

ASSESSING GAIT KINETICS WITH IOT-BASED WIRELESS SYSTEM

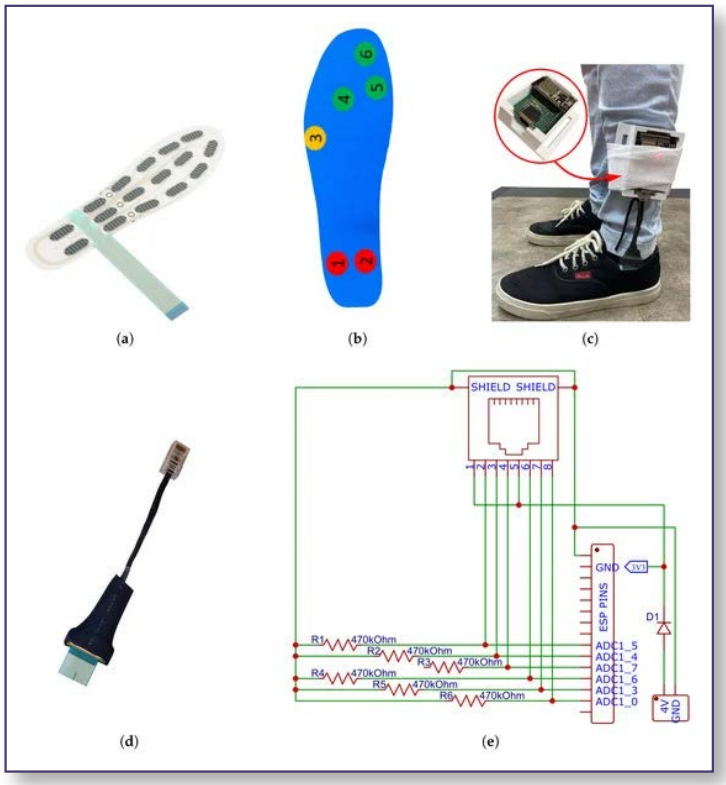


Figure: General components of the system. (a) Insole film sensor, (b) EVA lining, (c) prototype in use, (d) 8-wire Ethernet RJ-45 to FPC adapter, (e) electric diagram. Source: Authors.

In a new study from Brazil, researchers developed an Internet-of-Things (IoT)-based gait analysis system employing insole pressure sensors to assess gait kinetics. The system integrates piezoresistive sensors within a left foot insole, with data acquisition managed using an ESP32 board that communicates via Wi-Fi through an MQTT IoT framework (MQTT is messaging protocol for machine-to-machine communication) (see Figure). In this initial protocol study, they conducted a comparative analysis using the Zeno Walkway Gait Mat system (Protokinetics, Havertown, PA), supported by ProtoKinetics Software (PKMAS), to explore the correlation and agreement of data obtained from the insole system. Four volunteers (2 males and 2 females, aged 24–28, without gait disorders) walked along a 10-m Zeno system path equipped with pressure sensors while wearing the insole system. Vertical ground reaction force (vGRF) data were collected over 4 gait cycles. The preliminary results indicated a strong positive correlation (r = 0.87) between the insole and the reference system measurements. A Bland-Altman analysis further demonstrated a mean difference of approximately (0.011) between the 2 systems, suggesting a minimal yet significant bias. These findings suggest that piezoresistive sensors may offer a promising and cost-effective solution for gait disorder assessment and monitoring. However, operational factors such as high temperatures and sensor placement within the footwear can introduce noise or unwanted signal activation. The communication framework proved functional and reliable during this protocol, with plans for future expansion to multi-device applications. Additional validation studies with larger sample sizes are required to confirm the system's reliability and robustness for clinical and research applications.

Source: *Rathke CL, Pimentel VCdA, Alsina PJ, do Espírito Santo CC, Dantas AFOdA. IoT-based wireless system for gait kinetics monitoring in multi-device therapeutic interventions. Sensors. 2024; 24(17):5799. https://doi.org/10.3390/s24175799. Use is CC BY 4.0.*

DIABETIC FOOT ULCERS IN THE TIME OF COVID-19

A recent scoping review of the literature sought to understand the impact the COVID-19 pandemic had on the care of diabetic foot ulcers (DFUs). While the research team is from Ireland, they review literature from around the globe. Specifically, they analyzed data from 19 published studies, most on single site populations.

Ten of 12 studies reported on DFU outcomes and found a worsening of outcomes compared to pre-pandemic times. Reduced DFU presentations, alongside an increase in urgent hospitalizations and amputation, were key themes that emerged from this review. More high-quality evidence is needed to establish any longer-lasting effects of the COVID-19

Continued from page 22

pandemic on people living with DFUs. Further, the authors pointed out, there is a lack of evidence relating to the feasibility and success of telemedicine and limited data on changes to service delivery, including triage systems in this patient cohort.

Source: *Flynn S, Kirwan E, MacGilchrist C, McIntosh C. The impact of COVID-19 on the care of diabetic foot ulcers: A scoping review. J Tissue Viability. 2024; https://doi.org/10.1016/j.jtv.2024.06.016. Eprint ahead of publication. Use is per CC BY 4.0.*

PULMONARY COMPLICATIONS AFTER FEMUR FRACTURE REPAIR IN PATIENTS ≥80 YEARS

As the population of those age 80+ increases, surgeries for femur fractures will rise as well. A new 2-year retrospective cohort study in 479 patients (mean age 86 years) looked at the incidence and risk factors for common postoperative pulmonary complications—pneumonia, atelectasis, pulmonary edema, pleural effusion, and venous thromboembolism (VTE), as well as respiratory failure and 9-day mortality form a single hospital.

- Post-op complications occurred in 11.7%
- Pleural effusion was most common (4.4%) followed by pneumonia and atelectasis
- VTE occurred in 1.5%

Patients who developed pulmonary complications had

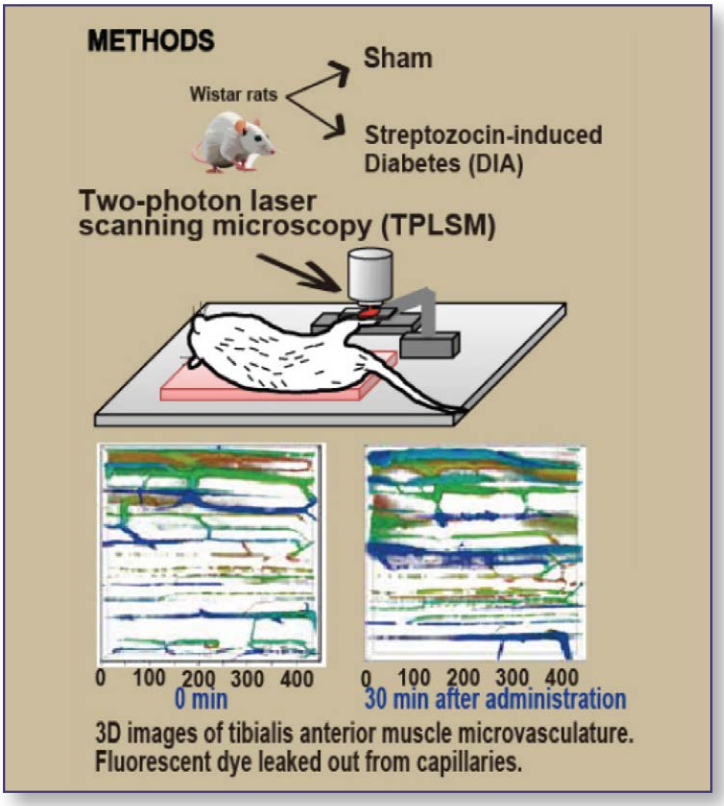
- Longer hospital stays 14 days vs 10 days (P <0.001)
- Greater need for oxygen supplementation (71.4% vs 31.4%, P <0.001)
- Higher all-cause 90-day mortality (14.3% vs 5.9%, P = 0.042)

Age, chronic lung disease, and Parkinson's disease were significant risk factors for pulmonary complications. Coronary artery disease, stroke, and prolonged surgery were significantly associated with respiratory failure, whereas internal fixation, coronary artery disease, and older age were associated with 90-day mortality. Distal femur fractures were significant risk factors for VTE, while VTE prophylaxis methods were not associated with VTE risk.

These findings highlight the importance of identifying comorbidities before surgery.

Source: *Chai J, Kang J, Seo WJ, et al. Incidence and risk factors of pulmonary complications following femur fracture surgery in patients aged 80 years and older. Clin Interv Aging. 2024;19:1843-1854. https://doi.org/10.2147/CIA.S481641.*

MICROVASCULAR PERMEABILITY IN DIABETIC MUSCLE



Microvascular permeability in diabetic muscle was investigated using our original 2-photon scanning laser microscopy method. Compared with controls, the leakage volume was increased in diabetic muscle, which was atrophic with smaller capillary diameter, endothelial cell thickening, and the appearance of more endothelial intercellular gaps or clefts, and large vesicles. Hyperpermeability was closely related to ultrafine structural changes of the capillary endothelial cell junctions.

Source: *Hotta K, Shimotsu R, Behnke BJ, et al. Effect of diabetes on microvascular morphology and permeability of rat skeletal muscle: in vivo imaging using two-photon laser scanning microscopy. J Appl Physiol (1985). 2024;137(4):963-974. doi: 10.1152/japplphysiol.00222.2024.*

Continued on page 25

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RUNNING IN MINIMAL SHOES VS BAREFOOT: SIGNIFICANT DIFFERENCE

Shoes affect the evolved biomechanics of the foot, potentially affecting running kinematics and kinetics that can in turn influence injury and performance. An important feature of conventional running shoes is heel height, whose effects on foot and ankle biomechanics remain understudied. Here, we investigate the effects of 6–26 mm increases in heel height on ankle dynamics in 8 rearfoot strike runners who ran barefoot and in minimal shoes with added heels. We predicted higher heels would lead to greater frontal plane ankle torques due to the increased vertical moment arm of the mediolateral ground reaction force. Surprisingly, the torque increased in minimal shoes with no heel elevation, but then decreased with further increases in heel height due to changes in foot posture. We also found that increasing heel height caused a large increase in the ankle plantarflexion velocity at heel strike, which we explain using a passive collision model. Our results highlight how running in minimal shoes may be significantly different from barefoot running due to complex interactions between proprioception and biomechanics that also permit runners to compensate for modifications to shoe design, more in the frontal than sagittal planes.

Photographs of the experimental shoe conditions. The low heel condition is a zero-drop minimal shoe of 6 mm sole thickness with no additional heel attached; medium heel condition has an additional 6mm heel for a total heel height of 12 mm, and the high heel condition has an additional 20 mm heel for a total heel height of 26 mm. (ler)

Source: *Yawar A, Lieberman DE. Effects of shoe heel height on ankle dynamics in running. Sci Rep. 2024;14(1):17959. doi: 10.1038/s41598-024-68519-z. Use is per the International Creative Commons License CC BY.*

STUDY EXAMINES FOOTWEAR PREFERENCES IN PEOPLE WITH KNEE OA

Although footwear can improve pain and function in individuals with knee osteoarthritis (OA), perspectives about footwear in this population have not been explored. This qualitative study explored preferences, attitudes and beliefs about footwear in adults with knee OA.

Twenty individuals with a clinical diagnosis of knee OA (age 45–79 years, 65% women) participated in semi-structured interviews about factors that influence footwear selection, the effect of footwear on knee symptoms, and footwear modifications. Data were analysed thematically.

Four themes, with sub-themes, were identified:

i) there are specific footwear characteristics people look for, with comfort as their top priority;

ii) shoe appearance is important;

iii) footwear can aggravate or ease symptoms; and

iv) people with knee OA find footwear in a variety of ways.

Participants related built-in arch support, a cushioned insole, and low/no heel, without addition of foot orthoses, to comfort, and were willing to pay more for comfort and quality. Appearance was also a consideration, and participants indicated they would tolerate short periods of symptom aggravation for aesthetic shoes. Participants felt that footwear choice affected their knee symptoms and risk of slipping/twisting. Participants reported that their footwear choices were determined through trial-and-error, and sometimes on advice from health professionals or shoe store salespersons.

The authors concluded that there are specific footwear features important to individuals with knee OA. Knowledge of these features can be used by health professionals to inform footwear discussions with knee OA patients and serve as considerations when developing footwear targeted for this population. (ler)

Source: *Smith MD, McKendry R, Shah S, et al. An exploration of footwear preferences, attitudes and beliefs in people with knee osteoarthritis: a qualitative study. Musculoskelet Sci Pract. 2024;72:102948. doi: 10.1016/j.msksp.2024.102948.*

RELIABILITY/VALIDITY OF ONESTEP SMARTPHONE APP ASSESSED

An easy-to-use and reliable tool is essential for gait assessment of people with gait pathologies. This study aimed to assess the reliability and validity of the OneStep smartphone application compared to the C-Mill-VR+ treadmill (Motek, Nederlands) among patients undergoing rehabilitation for unilateral lower extremity disability.

Spatiotemporal gait parameters were extracted from the treadmill and from 2 smartphones, 1 on each leg. Inter-device reliability was evaluated using Pearson correlation, intra-cluster correlation coefficient

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(ICC), and Cohen's d, comparing the application's readings from the 2 phones. Validity was assessed by comparing readings from each phone to the treadmill.

Twenty-eight patients completed the study; the median age was 45.5 years, and 61% were males. The ICC between the phones showed a high correlation (r = 0.89–1) and good-to-excellent reliability (ICC range, 0.77–1) for all the gait parameters examined. The correlations between the phones and the treadmill were mostly above 0.8. The ICC between each phone and the treadmill demonstrated moderate-to-excellent validity for all the gait parameters (range, 0.58–1). Only 'step length of the impaired leg' showed poor-to-good validity (range, 0.37–0.84). Cohen's d effect size was small (d < 0.5) for all the parameters.

The studied application demonstrated good reliability and validity for spatiotemporal gait assessment in patients with unilateral lower limb disability. ler

Source: *Marom P, Brik M, Agay N, et al. The reliability and validity of the OneStep Smartphone Application for Gait Analysis among patients undergoing rehabilitation for unilateral lower limb disability. Sensors (Basel). 2024;24(11):3594. doi: 10.3390/s24113594.*

A WORD ABOUT INJURY AFTER CONCUSSION...

In 2022, a report in the *International Journal of Sports Physical Therapy* found that college athletes who suffered a concussion possessed a 58% greater risk of sustaining a lower extremity musculoskeletal injury than those who did not have a history of concussion (RR = 1.58[1.30, 1.93]). Now, a new study by Gardner et al reports that for college male football players the odds of upper extremity injury in the year following first diagnosed concussion were 2.36 times higher (95% CI 1.13–4.95, $p = 0.02$). ler

Source: *Gardner CH, Kotlier JL, Fathi, A, et al. NCAA football players are at higher risk of upper extremity injury after first-time concussion. The Physician and Sportsmedicine. 2024: 52(6), 556–560. https://doi.org/10.1080/00913847.2024.2327275.*

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Your Video Telehealth Patients Are Watching… And Making Judgements

By Nathan Houchens, MD; Sanjay Saint,MD, MPH; Latoya Kuhn, MPH; David Ratz, MS; Jason M. Engle, MPH; Jennifer Meddings, MD, MSc

These study findings suggest you can improve patient trust and satisfaction with telehealth visits by minding your video background.

The COVID-19 pandemic prompted rapid adoption of telemedicine. Most physicians had no training on effective webside manner,[1] including their physical environment. Strategies for optimal visual elements during telemedicine visits have been based on professional expertise and not empirical data.[2,3] The preferred environment from which a physician conducts video visits remains unknown. Thus, we assessed patient preferences for various visual backgrounds during video visits.

Methods

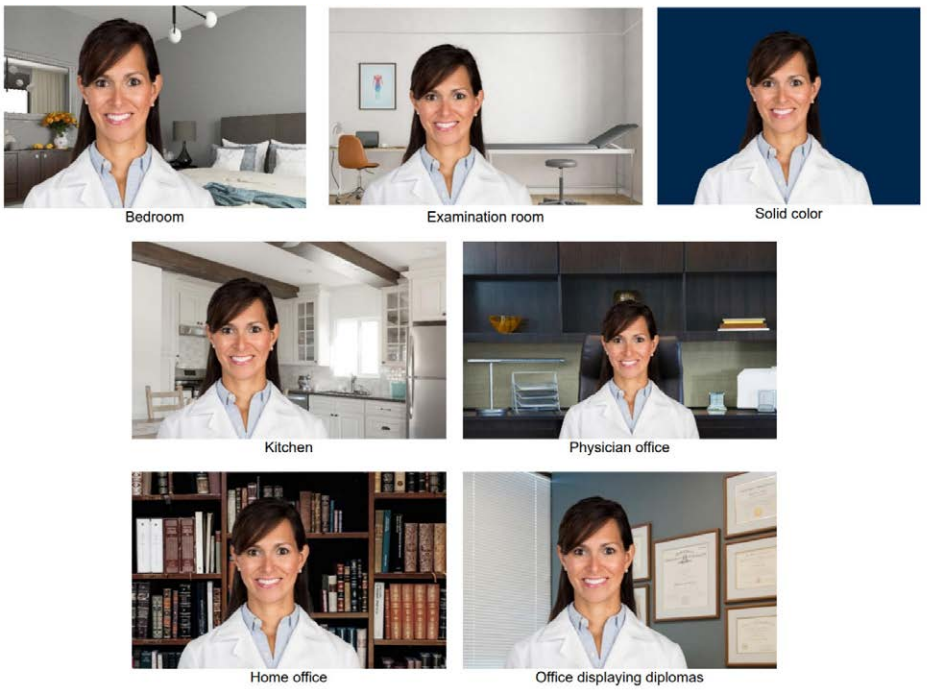
This cross-sectional study was approved by the University of Michigan and Veterans Affairs Ann Arbor Healthcare System institutional review boards. Survey completion implied consent. We followed the STROBE reporting guideline.

Data collection occurred between February 22 and October 21, 2022. Participants included a random sample of adults 18 years or older who had completed an in-person or virtual outpatient visit within the prior year at either institution. Race and ethnicity data were collected but not reported to protect confidentiality (given the majority of participants were White) and because this study was not powered to use these data in the analyses. Additional participants included registrants from a digital health research recruitment platform.

Paper and electronic surveys included photographs of a model physician in different environments (eFigure). Patients selected their preferred environment, and a composite score was calculated across 6 domains (how knowledgeable, trustworthy, caring, approachable, and professional the physician appeared, and how comfortable the physician made the respondent feel). Scores ranged from 1 to 10, with higher scores indicating greater preference.

Descriptive statistics were used to tabulate results. Mean composite score differences were assessed using linear regression, with a solid color background as the reference category. Differences in preferred environment for all physician types were assessed using multinomial logistic regression. Questions assessed 4 separate physician types (new and established primary care and new and established specialty); these questions were analyzed together, and standard errors were adjusted for repeated measures within participants. Statistical analyses were performed using SAS, version 9.4 (SAS Institute Inc). A 2-sided $P < .05$ was considered significant.

eFigure. Photographs of the 7 Environment Types



This article has been excerpted from "Patient Preferences for Telemedicine Video Backgrounds" by the same authors. *JAMA Netw Open*. 2024;7(5):e2411512. doi:10.1001/jamanetworkopen.2024.11512. Minor style editing has occurred. Use is per CC Attribution 4.0 International License.

Continued on page 30

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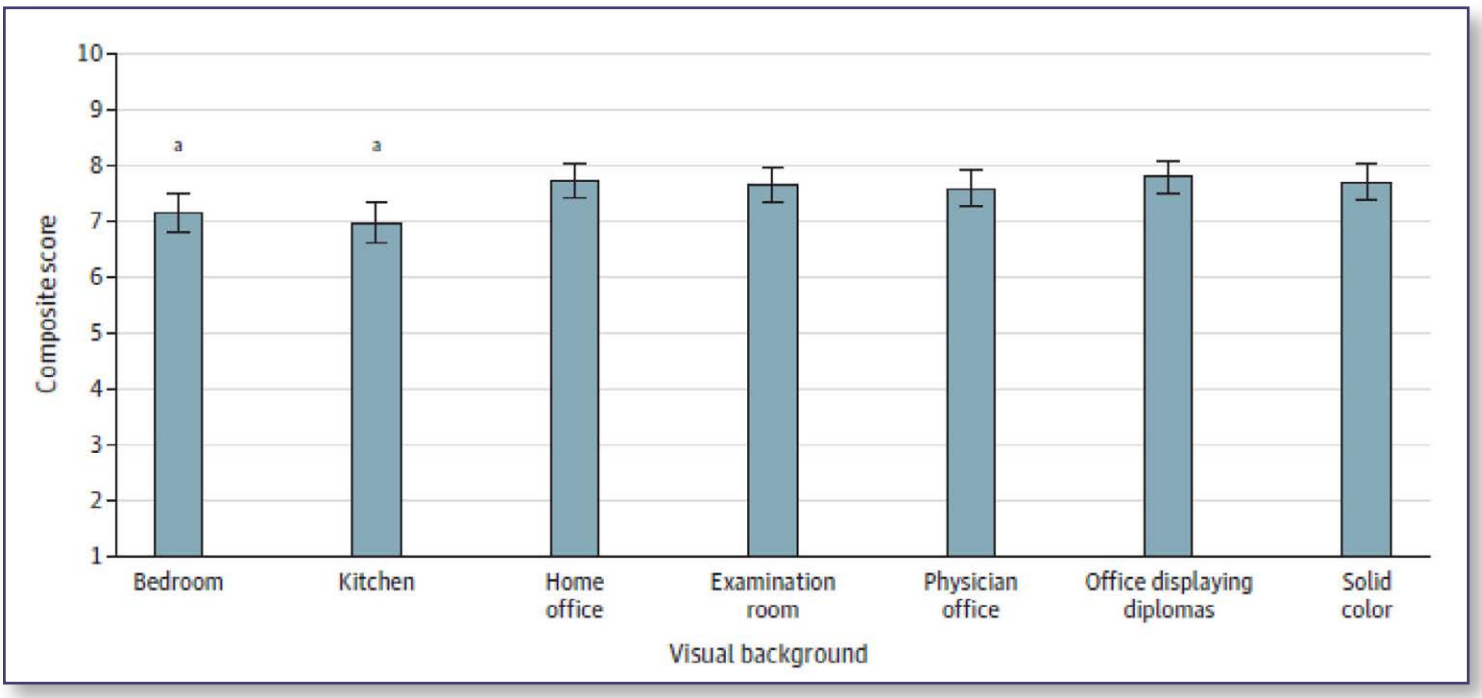
Figure 1: Preferences for Virtual Video Visit Background Environments



Higher scores indicate greater patient preference. The reference is the solid color background. Whiskers indicate SDs. a Statistically significant when compared with the reference ($P < .05$).

Results

A total of 1,213 patients returned surveys (response rates: university paper survey, 30%; veteran paper survey, 27%; university electronic survey, unknown); 637 patients (54.1%) were 65 years or older; 626 (53.3%) self-identified as female and 544 (46.3%) as male; and 28 (2.4%) self-identified as Asian, 91 (7.9%) as Black, 978 (84.7%) as White, and 57 (4.9%) as multiracial or other (including American Indian, Alaska Native, Arab or Arab American, Native Hawaiian, and other). The solid color background garnered a mean (SD) composite score of 7.7 (2.1). Other professional backgrounds (Figure 1) received similar scores. The physician office displaying diplomas was rated highest across 5 domains (mean [SD] composite score, 7.8 [1.9]). Significantly lower mean (SD) scores were 5 domains (mean [SD] composite score, 7.8 [1.9]). Significantly lower mean (SD) scores were calculated for the bedroom (7.2 [2.3]; P = .02) and kitchen (7.0 [2.5]; P = .002) environments.

The physician office displaying diplomas scored highest for all physician types. Considering all physician types together (a single respondent could choose a different preferred background for different physician types) and comparing with a solid color background (14.4%), respondents significantly preferred physician office (18.4%; $P = .007$) and physician office displaying diplomas (34.7%; $P < .001$) but significantly fewer preferred the bedroom (3.5%; $P < .001$) and kitchen (2.0%; $P < .001$) backgrounds (Figure 2).

Discussion

In this study, two-thirds of participants preferred a traditional healthcare setting background for video visits with any physician type, with physician office displaying diplomas rated highest. This background scored similarly to other traditional environments, whereas bedroom and kitchen were significantly less preferred.

Numerous studies have found nonverbal communication to be a modifiable determinant of patient trust and satisfaction.[4-6] To our knowledge, this is the first study to examine patient preferences for the physician's visual background. Limitations include low response rates for mailed surveys, emphasis on only 1 aspect of telemedicine encounters, and a focus on 2 institutions in 1 geographic region, which may affect generalizability. Nonetheless, findings suggest that patients may harbor specific preferences regarding the background environment used during telemedicine visits. Healthcare systems should prioritize performing telemedicine visits within a traditional office or examination room environment.

Nathan Houchens, MD, is with the Medicine Service in the Veterans Affairs Ann Arbor Healthcare System and the Department of Internal Medicine at the University of Michigan Medical School, both in Ann Arbor, Michigan.

Sanjay Saint,MD, MPH, is with the Medicine Service and the Center for Clinical Management Research at the Veterans Affairs Ann Arbor Healthcare System and the Department of Internal Medicine at the University of Michigan Medical School, all in Ann Arbor, Michigan.

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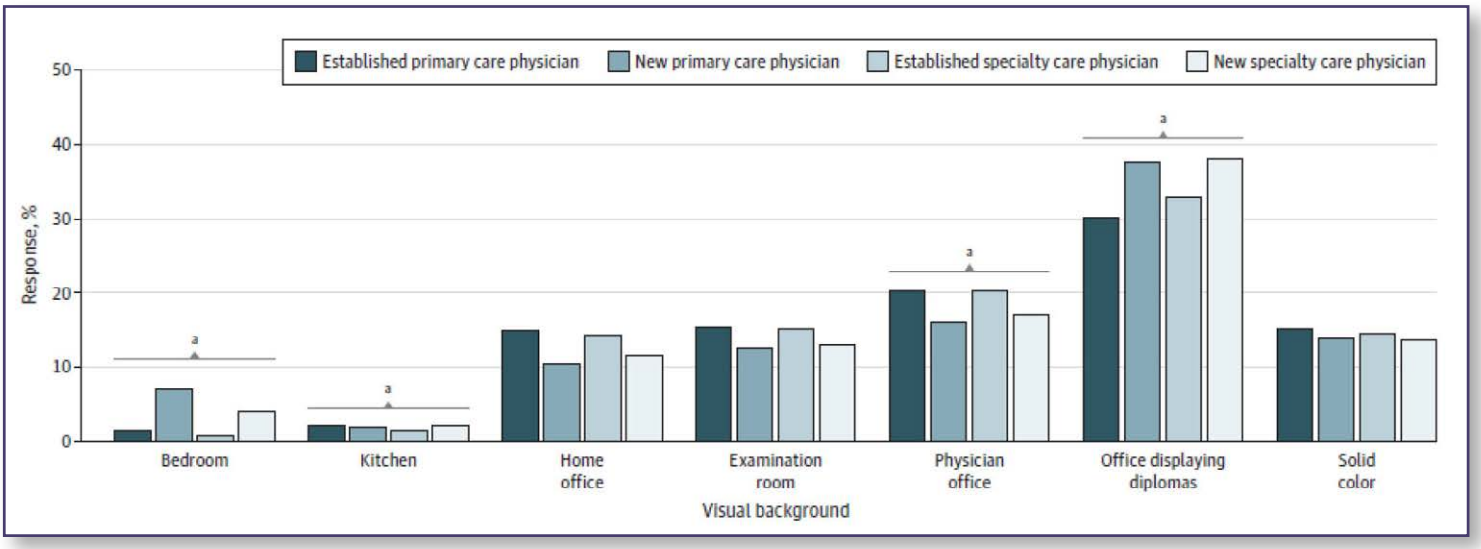
David Ratz, MS, is with the Center for Clinical Management Research at the Veterans

Figure 2: Preferences for Virtual Video Visit Background Environments by Physician Type



All physician types in each background are compared with all physician types in the reference category (solid color background).

[a] Statistically significant when compared with the reference ($P < 05$).

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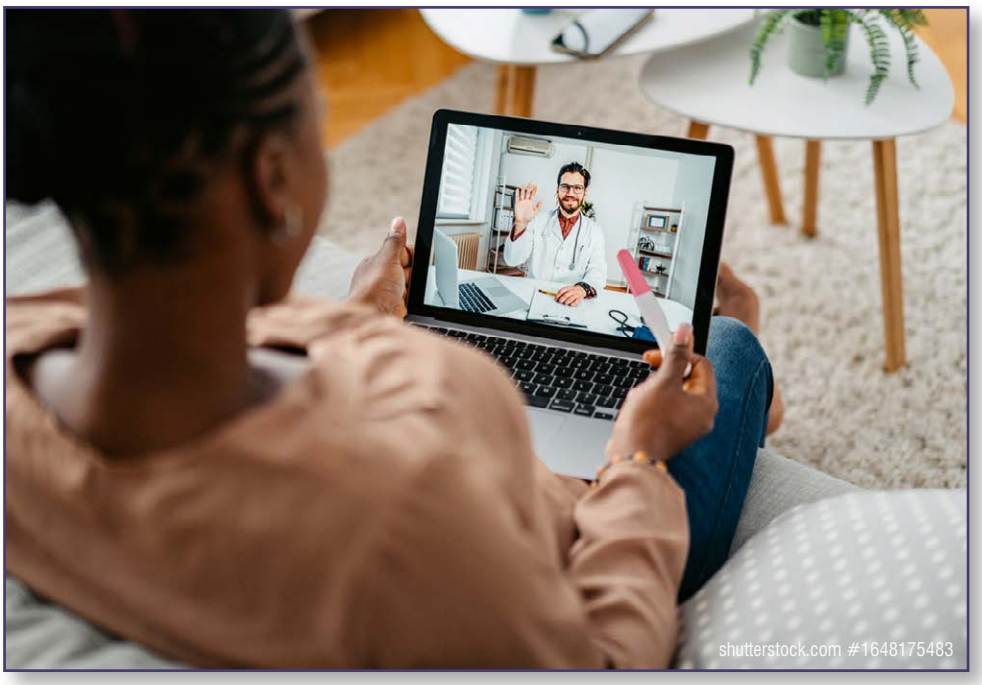

LOWER EXTREMITY REVIEW
ler

15 Celebrating 15 Years of Healthcare Innovations

11 Readers offer their thoughts on the greatest innovations of the last 15 years.

The dictionary defines innovation as the introduction or use of new ideas or ways of doing things. But it's really much more than that:

- In *What Customers Want*, innovation expert Anthony Ulwick wrote, "Innovation is not the result of thinking differently. It is the result of thinking deliberately (in specific ways) about existing problems and unmet needs."
- Others have added that innovation is a corporate mindset of continuous quality improvement that encourages improving processes or revising products in response to customer needs.

As part of LER's 15th anniversary celebration, we asked readers to weigh in on the many facets of innovation that have helped improve patient outcomes in lower extremity care. Here, we share some of their thoughts.

SMARTPHONE CLINICAL PRACTICE IN GAIT ANALYSIS

By Sarah A. Curran, PhD

Smartphones have revolutionized clinical practice through enhancement of communication with colleagues and patients, information access, and workflow efficiency for healthcare providers. With the continuous evolution of technology, smartphones have increasingly been used for assessing gait—providing a convenient and accessible way to monitor mobility, balance, and walking patterns. Gait assessment using smartphones typically involves using built-in sensors, such as accelerometers, gyroscopes, and magnetometers, which can capture detailed motion data. In essence, the use of smartphones for gait assessment has been linked to a growing body of research with several studies providing evidence supporting its validity and reliability, as well as application to a range of conditions. In a review of wearable devices and smartphones for gait analysis, Muro-de-la-Herran et al[1] found that smartphone sensors, particularly accelerometers and gyroscopes, were able to reliably capture gait parameters such as step length, cadence, and velocity. They concluded that smartphones could be a valid alternative to more traditional motion capture systems for basic gait assessment in non-laboratory settings.

Storm et al[2] validated the use of smartphone accelerometers to estimate spatiotemporal gait parameters in a group of healthy individuals. The authors found, when worn at the waist, smartphones provided estimates of gait speed, step length, and cadence with accuracy comparable to clinical tools such as the GAITRite system (CIR Systems, Inc.; New Jersey, USA), a commonly used gait analysis tool in rehabilitation. These findings are further supported by a most recent study by Tao and colleagues[3] who developed a WeChat mini-program (*MobileGait*) and used smartphone sensors to determine reliability and validity with healthy individuals, and to demonstrate the impact on gait parameters during single-task and dual-task walking in a cohort of cerebral small vessel disease patients. Additional studies have been undertaken in other patient populations, which includes the risk of falls prediction in older adults. Using smartphone sensors, Del Din et al[4] demonstrated that gait characteristics measured correlated well with clinical fall risk assessments, such as the Timed Up and Go test. Such findings can serve as a cost-effective and scalable solution for early detection of fall risk. Likewise, Su et al[5] investigated the potential of smartphone-based gait analysis to monitor Parkinson's disease progression. They showed that smartphone sensors could detect subtle changes in gait related to disease severity, such as reduced stride time and variability during single-task and dual-task conditions, making it a valuable tool for monitoring functional symptoms and outcomes.

While these studies are not an exhaustive list, they do collectively demonstrate that smartphones, with their ubiquitous availability and

advanced sensor technology, are a practical and effective tool for gait assessment across a range of settings and populations. As technology evolves and becomes more accessible, so will our ability to work with it to enhance our patient assessments and outcomes, as well as to monitor rehabilitation.

Prof. Sarah A. Curran, PhD, Professor of Podiatric Medicine and Rehabilitation, School of Sport and Health Sciences, Cardiff Metropolitan University, UK

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3-D PRINTING ALLOWS FOR ANATOMICALLY PRECISE PRODUCTS

BY PATRICK DEHEER, DPM

A close-up of a 3D-printed cobalt chrome talus bone implant printed by Restor3D. The company, spun out of Duke University in 2017, specializes in custom implants used for trauma and oncology cases, and off-the-shelf 3D-printed implants that have been cleared by the FDA.

In the past 15 years, lower extremity healthcare has seen numerous innovative products that have improved patient outcomes. Determining which product has had the greatest impact is debatable, but 3-dimensional (3D) printed technologies stand out. These include non-customized implants, custom implants, patient-specific instruments and cut guides, and anatomic biomodels.

3D printing utilizes 2 methods: additive manufacturing, where material is built up in layers, and subtractive manufacturing, where material is removed from a base to create patient-specific products.

The complexity of the foot and ankle often leads to significant deformities due to disease, trauma, or biomechanical issues, which previously lacked reliable solutions. Now, engineering teams can create anatomically precise products based on CT scans and radiographs, collaborating closely with surgeons to tailor these devices to individual needs.

In complex cases involving segmental bone loss, deformity correction, and arthrodesis, 3D-printed implants enable predictable results that help maintain limb function and enhance patients' quality of life. Osseous integration, or direct bonding of bone to an implant, offers an advantage over traditional bone grafts, making 3D-printed implants a valuable tool in complex reconstructive surgeries.

Patrick DeHeer, DPM FACFAS, FFPM RCPS (Glasg) is now Medical Director at Upperline – Indiana and Podiatric Residency Director at Ascension St. Vincent Hospital in Indianapolis.

MPFF INTRODUCED INTO U.S. FOR VENOUS & LYMPHATIC DISEASE

BY JOHN CHUBAK, MD, FACS

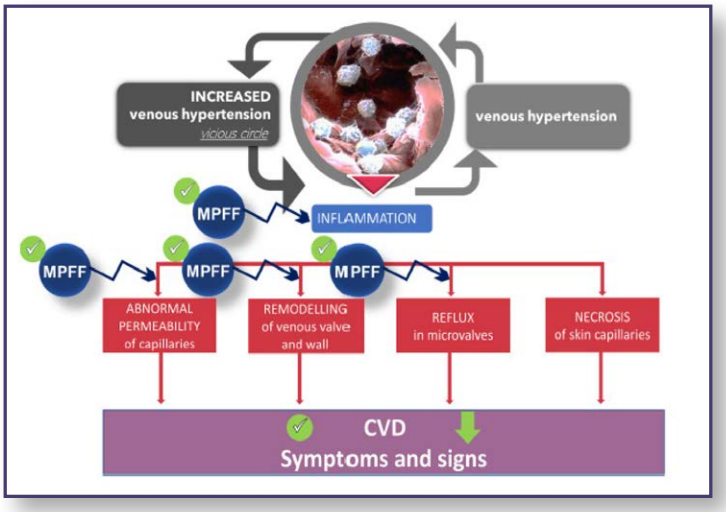

Figure 1. Effects of MPFF on the pathophysiological processes that cause the signs and symptoms of Chronic venous disease. MPFF, micronized purified flavonoid fraction. Reprinted from Lurie F, Branisteanu DE. Improving chronic venous disease management with micronised purified flavonoid fraction: New evidence from clinical trials to real life. Clin Drug Investig. 2023;43(Suppl 1):9-13. doi: 10.1007/s40261-023-01261-y. Use is per Creative Commons License CC BY 4.0.

Continued on page 35

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Continued from page 33

As a board-certified cardiovascular surgeon specializing in venous and lymphatic disease, I firmly believe that the introduction of micronized purified flavonoid fraction (MPFF) into the U.S. market represents perhaps the most important innovation in daily practice we've seen in the last 10 years. This advancement is crucial for supporting venous and lymphatic function by preventing inflammatory sequela and microcirculatory dysfunction caused by venous hypertension (Figure 1). Venous or lymphatic disorders are believed to affect 50% of U.S. citizens, creating a substantial public health burden.

MPFF, a dietary supplement, has garnered significant recognition, being recommended in all clinical practice guidelines from esteemed organizations such as the Society for Vascular Surgery, the American Vein and Lymphatic Society, and the American Venous Forum. These endorsements underscore its efficacy and safety, marking a pivotal paradigmatic shift in philosophy.

The benefits of MPFF are manifold. It not only helps support vein function in patients with chronic venous insufficiency, but also supports overall vascular health. By improving microcirculation and reducing inflammation through its antioxidant mechanism of action, MPFF aids in the prevention of more severe complications, ultimately enhancing patients' quality of life.

Vein Formula and Lymphatic Formula, introduced by VitasupportMD, are simple to incorporate into daily routines and act as excellent adjuncts to other standard treatments. This innovation aligns with our ongoing efforts to provide holistic care, emphasizing patient well-being and compliance.

The availability and guideline endorsement of MPFF in the U.S. is a significant step forward in the management of the venous and lymphatic systems and reinforce the importance of improving patient outcomes by providing a comprehensive approach to care, which includes systemic dietary supplements. ler

John Chuback, MD, FACS, is co-founder of VitasupportMD in Paramus, NJ.

CONTINUOUS TOPICAL OXYGEN THERAPY FOR WOUND CARE

By Windy Cole, DPM, CWSP

The utility of supplemental oxygen to support wound healing has been well-documented in the literature. Following injury, poor blood circulation, edema, injured microcirculation, and contraction of vessels in traumatized tissue limit oxygen distribution to a wound, thereby reducing the wound's capacity to heal. Oxygen plays an essential role in multiple wound-healing processes including oxidative killing of bacteria, cellular signaling through growth factors and cytokines, and proliferation, collagen deposition, and angiogenesis. Thereby, increasing oxygen levels via supplemental oxygen in the ischemic tissue reverses hypoxic conditions, reduces ischemic pain, supports the healing process, reduces inflammation, and decreases the risk of infection and biofilm.

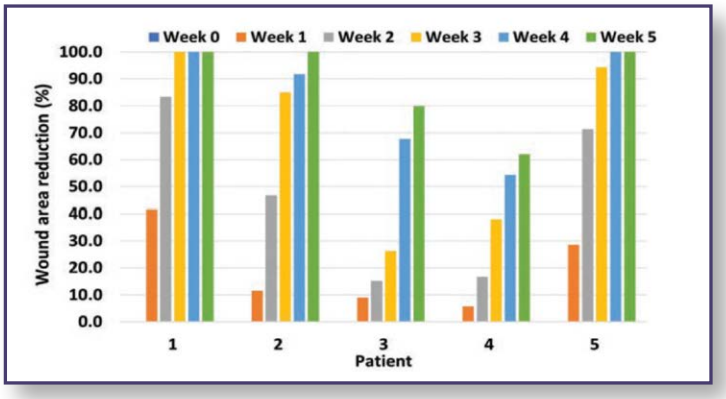

Figure 2. Percentage wound area reduction over the 5-233k observation period. Reprinted from Cole W, Woodmansey E. Monitoring the effect of continuous topical oxygen therapy with near-infrared spectroscopy: a pilot case series in wound healing. Wounds. 2024;36(5):154-159. doi: 10.25270/wnds/23150.

Various methods of supplying supplemental oxygen therapy include hyperbaric oxygen therapy (HBOt) and topical oxygen therapy (TOT). HBOt involves delivering systemic oxygen to the patient via a high-pressure chamber for 90 minutes 5 days a week. HBOt is available at specialty clinic or hospital locations and is not portable. Thus, HBOt is not suitable for home or community use. However, continuous topical oxygen (cTOT) devices are now widely available. cTOT represents a significant advancement in delivering supplemental oxygen treatments to patients suffering with chronic wounds. cTOT devices are innovative, easy to use, and lightweight, delivering continuous oxygen directly to the wound bed. cTOT devices are portable, thus oxygen delivery is maintained 24 hours a day, 7 days a week, allowing the patient to continue to perform activities of daily living uninterrupted. The treatment is low-risk and is easy to use in a wide range of care settings and in a variety of chronic wound types. Understanding the utility of cTOT as an alternative method of chronic wound pain management has

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the potential to impact a large segment of the population who do not have access to effective treatment options.

Dr. Cole has practiced in Northeast Ohio for over 22 years. She is an adjunct professor and Director of Wound Care Research at Kent State University College of Podiatric Medicine. She is double board certified by the American Board of Foot and Ankle Surgery and the American Board of Wound Management. She is an ACCWS board member and a Fellow of the Royal College of Physicians and Surgeons Glasgow. She has been a dedicated wound care advocate for two decades with interests focused on medical education, diabetic foot care, wound care, limb salvage, & clinical research.

SMARTPHONE SCANNING FOR ORTHOTICS

By Robert Weil, DPM

Prescription orthotics have always been a crucial part of my sports podiatry practice. Athletes of all sports, levels, and ages expect comfort and positive results with their foot, ankle, knee, and postural problems from using their orthotics. Let's also include enhanced performance among those benefits. However, preciseness and accuracy of the prescription along with manufacturing turnaround time are key! My figure skating specialty with boot-fitting demands and alignment criteria are good examples.

An exciting innovation advance to the orthotics world with the new smartphone 3D technology was introduced to me by orthotics consultants at Henhat's lab and my long time "orthotics guru" lab manager Darrin Harpham. I have forever used neutral position plaster casting with FAB results from superstars to kids and grandmas and was a very tough sell for any scan alternatives (Figure 3), let alone scans with my iPhone! Even with the time-consuming and messy casting always included, as well as turnaround time challenges, I was always stubborn and reluctant to depend on any of the available alternatives. Darrin also initially felt the same cautious reluctance. Well, my how times have changed!

Orthotics and foot scanning has been available for some time at walking and running shoe stores and with some podiatrists and physical therapists, but I always questioned their accuracy and results. Too many patient complaints and necessary orthotics adjustments were

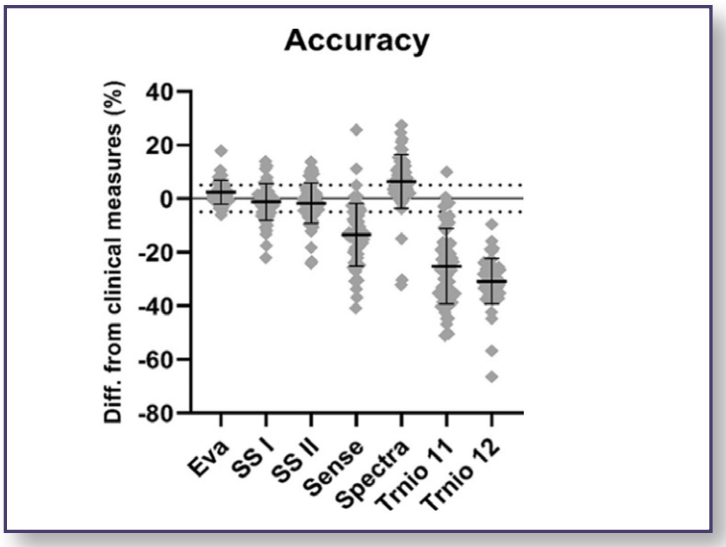

Figure 3. Percentage difference between clinical measures and 3D scans of the foot, ankle and lower leg. The 3D scanners are: Artec Eva (Eva), Structure Sensor I (SSI), Structure Sensor II (SSII), Sense, Spectra, and Trnio applications for iPhone 11 (Trnio 11) and iPhone 12 (Trnio12). Positive differences in the y-axis show that the 3D scan was larger in size than the clinical measurement. Dotted line represents 5% difference.

**Trnio has since retired the apps used here.*

Reprinted from Farhan M, Wang JZ, Lillia J, Cheng TL, Burns J. Comparison of multiple 3D scanners to capture foot, ankle, and lower leg morphology. Prosthet Orthot Int. 2023;47(6):625-632. doi: 10.1097/PXR.0000000000000230. Use is per Creative Commons License CC BY.

needed. I was pleasantly surprised with not only my personal positive consistently great results with patients and athletes over this past year, but also with lab feedback from other podiatrists and doctors with the new iPhone 3D phone scanning. Big step up!

With some easy and proper instructions for technique and methods provided by the lab, podiatrists can really take advantage of this progressive innovation for themselves and their patients.

Robert A. Wei, DPM,l is a sports podiatrist in private practice in Lisle, Illinois. He hosts "The Sports Doctor," a live weekly radio show on bbsradio.com, or you can visit his website, thesportsdoctorradio.com. His book, #HeySportsParents written with Sharkie Zartman, is available on Amazon.com. Dr. Weil was inducted into the prestigious National Fitness Hall of Fame in April 2019. Find him at thesportsdoctorradio.com.

Continued on page 39

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ADVANCEMENTS IN SURGICAL SOLUTIONS AND PATIENT REHABILITATION

By Gary Justak

The STAR® Ankle 3-piece mobile bearing ankle implant.

Over the last 15 years, the foot and ankle landscape has witnessed a seismic shift marked by ingenious solutions that have transformed surgical techniques, introduced a new breed of innovative products, and reshaped patient recovery. Close collaboration with surgeon partners has been key in the development of multiple innovations. Three advancements stand out for me:

1. The integration of NiTiNOL technology in hindfoot fusion surgeries, highlighted by DynaNail Helix™. NitiNOL (a combination of nickel and titanium) is a metal alloy that has the unique ability to change shape and still fully recover back to its original geometry. By incorporating NiNiTOL's sustained dynamic compression, known for improving fusion rates and times, Helix enhances surgical efficiency and facilitates optimal healing.
2. Minimally invasive surgery (MIS) has gained prominence, enabling better outcomes for some of the most high-volume procedures in lower extremity care. As a leader in the MIS charge, our latest percutaneous Lapidus correction system, Tarsoplasty, merges multiple clinical advantages of percutaneous surgery with the powerful correction of a traditional Lapidus procedure, ensuring accurate anatomical alignment and guided fixation.
3. STAR® Ankle, the first 3-piece mobile bearing ankle implant approved for uncemented use by the US Food and Drug Administration in 2009 in the United States. And the recently added surgical e+™ Polyethylene vitamin upgrades—1, a moderately-cross linked formula for sliding and gliding kinematics, and a second highly-cross linked formula for ball and socket–type kinematics, both have been demonstrated to significantly reduce oxidation and long-term wear.*

With excitement for the future, we remain committed to redefining every step for every patient.

**Data on File.*

Gary Justak, is President and General Manager of Enovis™ Foot & Ankle in Lewisville, Texas. To learn more about the Enovis journey, visit www.enovis.com/foot-and-ankle.

PCR TESTING FOR PODIATRIC NAIL & SKIN DISORDERS

By William P. Scherer, DPM, MS

PCR (Polymerase Chain Reaction) testing is a transformative innovation in diagnosing nail and skin disorders within podiatry. Introduced for podiatric medicine about 15 years ago, PCR enables the rapid amplification of specific DNA sequences, making it a powerful tool for identifying fungal and bacterial infectious agents that cause various dermatological conditions. This capability is also crucial for diagnosing infectious diseases, including viral infections like COVID-19, where timely and accurate detection can significantly impact public health responses.

In podiatry, PCR testing is especially valuable for accurately diagnosing fungal nail infections (onychomycosis) and skin infections, such as athlete's foot and cellulitis (Figure 4). Traditional KOH prep and fungal culture methods can be inaccurate and sometimes take several weeks for results, while PCR testing provides rapid and precise identification of pathogens (genus and species), with a higher sensitivity and specificity than older methods, allowing for individualized treatment plans that can improve patient outcomes. This is crucial in cases where timely diagnosis

Continued on page 41

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Figure 4. White superficial onychomycosis (WSO) or leukonychia trichophytica caused by Trichophyton rubrum. Mixed form of WSO with distal subungual onychomycosis; 63-year-old patient. From Nenoff P, Reinel D, Mayser P, et al. S1 guideline onychomycosis. JDDG: Journal der Deutschen Dermatologischen Gesellschaft. 2023;21:678–692. https://doi.org/10.1111/ddg.14988.

can prevent the spread of infection or more severe complications.

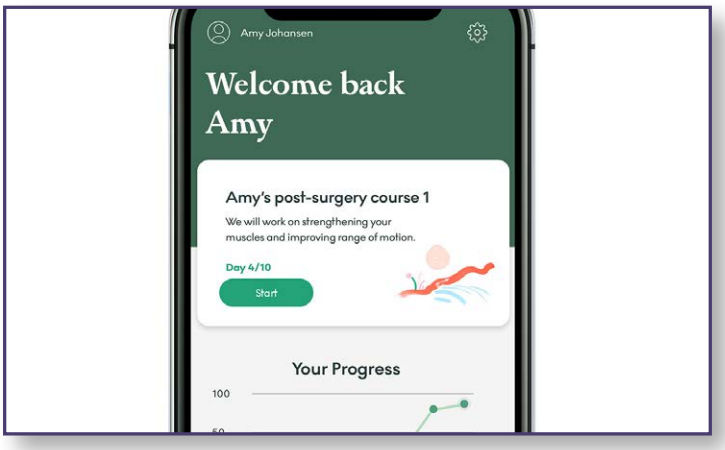
Additionally, PCR technology can help differentiate between different types of fungi (including Terbinafine-resistant strains) and bacteria, ensuring that patients receive the most effective antifungal or antibiotic therapies. This specificity reduces the risk of misdiagnosis and ineffective treatments, which can prolong suffering and lead to chronic conditions. This ensures that patients receive prompt diagnoses and appropriate care, particularly important for those with compromised health, such as geriatric patients with diabetes.

William P. Scherer, DPM, MS, is a Senior Podiatric Medical Advisor at Bako Diagnostics in Delray Beach, Florida. Before joining Bako, he had practiced podiatric medicine and surgery for more than 25 years in Delray Beach.

REDUCING FALLS WITH REMOTE MOTION ANALYSIS

By William Dieter, PT, DPT, GCS, FSOAE

Since we announced our partnership with OneStep in April 2023, FOX Rehabilitation has seen strong results for our residents, with their smartphones turned into clinical-grade motion analysis labs. OneStep's



The OneStep Smartphone interface.

innovative remote care platform has empowered our clinicians to extend patient care beyond in-person visits using remote therapeutic monitoring (RTM), improving clinical outcomes, increasing patient engagement, lowering healthcare costs, and continuing to grow FOX's reputation as a healthcare innovator.

The collaboration has delivered tangible results, including a 45% reduction in fall rates and a 58% improvement in residents' functional capabilities. FOX clinicians' workflows have even improved, with the amount of time spent triaging resident care was cut in half and a 97% success rate for resident RTM billing was achieved.

Recently, this partnership was honored with the Innovator of the Year Award (Silver) at the 2024 McKnight's Tech Awards. We're excited to continue scaling this forward-thinking technology across our senior living communities, building on our commitment to improving and extending the lives of our residents.

William Dieter, PT, DPT, GCS, FSOAE, is Senior Clinical Director at Fox Rehabilitation FOX Rehabilitation, a nationwide geriatric home-care provider, based in Cherry Hill, New Jersey.

ACCESSIBILITY OF TECHNOLOGY FOR REAL WORLD CARE

By Antonio Robustelli, MSc, SCS

The last 15 years have represented an exciting period of innovation in the field of sports medicine and sport science. We have witnessed the

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increased accessibility of advanced technologies that were previously available only in high-grade research-lab environments and top-level clinics and centers.

Practitioners in sports medicine and sport science have been able to gain a deeper understanding of an athlete's health and performance by assessing valuable metrics in real time directly on the field of play: wearables, cloud accessibility, and athlete management systems have completely revolutionized the way practitioners provide athletes with proper care and performance support.

However, from my perspective, the most important and relevant innovation has been related to a mind shift toward the athlete's care and the awareness of the necessity for a multifactorial team that is able to properly manage the complex nature of sports performance.

While wearables and technologies to monitor recovery, sleep, fatigue, and stress levels do represent innovations in and of themselves, to my mind they are the natural result of a more holistic approach to an athlete's performance and health.

Research has highlighted the importance of the interconnection among different elements (ie, physiology, chemistry, biomechanics, environment, behavior, social life, nutrition, etc.) toward the expression of an individual performance blueprint, and practitioners have become progressively accustomed to the complexity of human beings and the need of a comprehensive approach to sports and health phenomena.

Thus, it's the positive mind shift toward a synthesis approach versus a traditional analytical approach that has represented the most impactful innovation in the last 15 years. ler

Antonio Robustelli is a professional sports performance consultant and elite coach from Italy. He is also a member of the LER Editorial Advisory Board and can be reached at Antonio.Robustelli@omni-athlete.com.

TECHNOLOGY ADVANCES IN ENVIRONMENT OF CONTINUOUS QUALITY IMPROVEMENT

By Wade Bader, CPO

The Noodle Classic AFO from Kinetic Research

Technology stems from the inherent human desire to improve on what we already know. As our pool of knowledge grows, new bases are formed that set the stage for the next innovation.

The desire to find better, cheaper, faster solutions transcends every field. People sometimes notice the big changes and reflect on how crude it was before, not always realizing how many steps it took to make that change happen. We remember the monumental achievement of landing a man on the moon in 1969, but that 1 event was the culmination of over 1,000 new technologies brought together to make the mission possible. Thirty-three years later, Space-X was born, and 20 years thereafter, with some failures along the way, they have revolutionized how we work in space. SpaceX didn't invent the rocket, but they made it efficient and reliable. Over the years, the company's expanding understanding and mastery of their work allowed them to address even more complex needs of their customers. SpaceX continues to innovate and expand with the Starlink system that was only made possible through the milestones achieved at SpaceX.

When I relate this to my experience at Kinetic Research, we started in the early 1990s using our knowledge of that time to create composite ankle-foot-orthoses (AFOs). As our understanding and mastery expanded, our ability to address complex deformities expanded. In 2009, we introduced the Noodle AFO, a dynamic, energy-storing AFO that was

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reliable, durable, and efficient. Expanding on the Noodle, in 2015 we introduced the SOTO design, which has at its core a Noodle AFO, but then we integrate a flexible hemi-supramalleolar orthosis (SMO) into the AFO, making it a game changer for medio/lateral control. Could we have skipped the first 20 years and jumped straight to the SOTO? The answer is obviously no. To get where we are today, we needed those years of experience and an environment of continuous quality improvement.

Wade Bader, CPO, is President of Kinetic Research in Tampa, Florida.

WHEN SNEAKERS AND SCIENCE COLLIDE: GAME-CHANGING TECH AT THE 2024 OLYMPICS

By Sarah Clark, MS, ATC

The 2024 Paris Olympics were nothing short of thrilling. Snoop Dogg and Martha Stewart hilariously guided us through the City of Lights with their unique blend of humor and charm. Athletes swam in the Seine, volleyball matches unfolded under the shadow of the Eiffel Tower, and breakdancing made its Olympic debut. The excitement was palpable, both for those in attendance and those watching at home. Reflecting on past Olympics and seeing how technology has evolved across sports is fascinating, but this year, something truly groundbreaking stole the spotlight.

Hellen Obiri, the phenomenal Kenyan distance runner and 2-time Olympic silver medalist, made history—not just with her incredible performance but with her choice of footwear. Hellen sported the Cloudboom Strike LS from On, a sportswear company known for pushing the envelope. But here's the twist: this wasn't your typical sneaker. It was a spray-on shoe! Yes, you read that right. On has developed a revolutionary technology called LightSpray (LS), and it's as fascinating as it sounds. Imagine a robot placing a foot form on its arm, then spraying on the entire upper part of the shoe in 1 continuous filament. The whole process takes just 3 minutes! Fast Company recently highlighted this game-changing technology, and it's set to transform the world of sportswear.

So, what does this mean for athletes like Hellen Obiri? First and foremost, it promises a perfectly customized fit, crucial for comfort and peak performance. The efficiency and precision of the spray-on method could also revolutionize sportswear manufacturing, making it more sustainable by reducing waste and conserving resources.

Hellen's decision to wear the Cloudboom Strike LS at the Olympics

Cloudboom Strike LS

is more than just a fashion statement; it's a bold move that showcases how technology can reshape athletics. She wasn't just running for gold—she was running for innovation, making this a truly historic moment. And what a race it was! Hellen won the bronze medal in the Women's Marathon for Kenya, setting a personal best with a time of 2 hours, 23 minutes, and 10 seconds—just 15 seconds shy of the gold medal! Hellen also secured back-to-back victories at the Boston Marathon (2023 and 2024) and triumphed at the New York Marathon (2023). Impressively, she became the first woman since 1989 to win both the Boston and New York Marathons in the same year. It should be noted that she did wear the spray-on shoe in the 2024 Boston Marathon.

Hellen Obiri's spray-on shoes are a perfect example of how technology can shake things up—not just in sports, but in so many areas, like medicine. When we step outside the box and challenge what's considered normal, we open the door to incredible possibilities that can change the game. Whether it's improving athletic performance or transforming patient care, innovation is the key to progress.

So, let's take a page from On's playbook and start thinking about how we can bring that same forward-thinking mindset into our own fields. How are you disrupting the norm and making an impact? The future is wide open, and it's up to us to shape it. Let's get to work!

Sarah Clark, MS, ATC, is a healthcare consultant who helps independent medical practices transform chaos into calm. With over two decades of experience, she uses her "4 Ps to Success" framework—People, Patients, Paperwork, and Processes—to optimize practice efficiency. As a Fractional Practice Administrator, Sarah provides hands-on support to improve patient care, boost staff morale, and increase profitability. Her workshops and keynotes cover topics from Process Improvement to enhancing patient experience. Ms. Clark's entry is an edited version of a a recent blog post which can be found at sarahclarkconsulting.com.

Cell Phone-Related Lower Extremity Injuries While Walking

By Mathias B. Forrester, BS

Background: Ninety-seven percent of people in the United States (US) own a cell phone. Consequently, millions of people are at risk of cell phone-related injury, including when using or carrying a cell phone while walking. This study described cell phone-related lower extremity injuries while walking that were treated at US hospital emergency departments (EDs).

Methods: An analysis was performed of cell phone-related lower extremity injuries while walking reported to the National Electronic Injury Surveillance System during 2000-2023. National injury estimates were calculated for selected variables.

Results: An estimated 13,264 cell phone-related lower extremity injuries while walking were treated at US hospital EDs during 2000-2023, representing 35.5% of the estimated 37,344 such injuries affecting all body parts. The estimated number of lower extremity injuries increased from 34 during 2000-2003 to 4,477 during 2016-2019 and then declined slightly to 4,381 during 2020-2023. The activity during which the lower extremity injury occurred was 64.4% texting on or looking at the cell phone, 16.6% talking on the cell phone, and 19.1% other or unknown activity. The mechanism of the injury was 63.1% fall, 8.3% hit or hit by another object, 6.4% hit or hit by a vehicle, and 22.2% other or unknown. The location of the incident was 27.5% other public property, 16.9% home, 16.3% street or highway, 2.5% school, 1.5% place of recreation or sports, 0.6% industrial place, and 34.8% not recorded.

Conclusions: Although the estimated number of cell phone-related lower extremity injuries while walking that were treated at US hospital EDs appears to have stabilized in recent years, it remains a problem. Such injuries most often occurred while the patient was texting on or looking at the cell phone, and the majority involved a fall. While the highest proportion of the injuries occurred at other public property, the next most common location was the home. The results of this study may be useful for creating educational activities that can reduce the occurrence of these injuries.

Table 1. Activity and mechanism of cell phone-related injuries while walking treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE rate (%)
	Estimate	%	Estimate	%	
Activity					
Texting on or looking at cell phone	8,542	64.4	2,2487	60.2	38.0
Talking on cell phone	2,196	16.6	7,262	19.4	30.2
Other or unknown	2,527	19.1	7,595	20.3	33.3
Mechanism of injury					
Fall (including trip or slip)	8,368	63.1	23,381	62.6	35.8
Hit or hit by another object	1,104	8.3	7,927	21.2	13.9
Hit or hit by a vehicle	852	6.4	2,501	6.7	34.0
Hit or hit by cell phone	0	0.0	64	0.2	0.0
Other or unknown	2,941	22.2	3,471	9.3	84.7
Total	**13,264**		**37,344**		**35.5**

LE rate = lower extremity injury estimate/total injury estimate, presented as a percentage.

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 estimate is <1,200.

According to a January 2024 Pew Research Center fact sheet, 97% of people in the United States (US) own a cell phone of some kind.[1]

Injuries may occur while using a cell phone, and these injuries may occur under a variety of circumstances. One of the more recognized circumstances is walking while using or carrying a cell phone.[2-4] (See also "Smartphone Usage Negatively Impacts Standing Postural Balance, page 17, and "Does Texting While Walking Affect Gait's Plantar Pressure Parameters?", page 17.)

Studies have reported that 20-25% of people engage with technology-related distractions while walking.[5-8] Distracted walking can negatively affect walking safety through such factors as reduced situation awareness, unsafe walking behaviors, slower speed, greater deviation from walking in a straight line, and increased near collisions with other pedestrians.[5,8-12]

The objective of this study was to describe cell phone-related lower extremity injuries while walking. A previous study found that 25% of ambulatory cell phone injuries treated at US emergency departments (EDs) involved the lower extremity.

Methods

Data for this study were downloaded from the National Electronic Injury Surveillance System (NEISS) website at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS database has previously been described in *Lower Extremity Review*.[13] In brief,

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operated by the US Consumer Product Safety Commission (CPSC), NEISS collects data on consumer product- and activity-related injuries from the EDs of approximately 100 hospitals as a probabilistic sample of the more than 5,000 US hospitals with 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.[14,15] Since data are publicly available and de-identified, the study is exempt from institutional review board approval. Previous studies used NEISS data to examine cell phone-related injuries. However, these studies either did not focus on injuries while walking[16,17] or did not focus on lower extremity injuries.[2-4]

Cases were cell phone-related injuries while walking reported to the NEISS during 2000-2023. The NEISS database includes three numeric fields for coding the product or activity involved in the injury (Product_1, Product_2, Product_3). (Product_3 was added to the NEISS database in 2018 but does not appear to have been used until 2019.)[15] The NEISS database has product code 550 (telephones or telephone accessories); however, this code is not only used for cell phones but also for landline phones, intercoms, and other such devices. Thus, the product code alone cannot be used to identify cell phone-related injuries. For this analysis, first, all records with code 550 in any of the three product code fields or "phone" in the Narrative text field (a text field that briefly summarizes the circumstances of the injury) were identified. Next the Narrative fields were individually reviewed to determine whether the injury appeared to be related to using or carrying a cell phone while walking. A record was included even if it did not explicitly state that the phone was a cell phone but the context suggested that the phone was a cell phone. For example, if the Narrative field stated that the person was talking on a phone on the street and fell down a manhole, it was assumed that the person was not talking on a landline phone. At the same time, the activity at the time of the injury and the mechanism of the injury were noted. The activity at the time of the injury was grouped into texting on or looking at the cell phone, talking on the cell phone, and other or unknown (eg, carrying a cell phone, "using" a cell phone, "on" a cell phone). The mechanism of the injury was grouped into a fall (including trip or slip), hit or hit by a cell phone, hit or hit by a vehicle, hit or hit by another object, and other or unknown (including a person "rolled" a body part but a fall was not explicitly mentioned).

The variables examined were the affected body part, activity at the time of the injury, mechanism of the injury, year and month of treatment, patient age and gender, location of the incident, injury type (diagnosis), and patient disposition. 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.[15] For consistency over the entire study period, the Body_Part and Diagnosis fields alone were examined for the analysis.

Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). For the selected variables, the distribution of the national injury estimates was determined for cell phone-related injuries while walking affecting any body part and the subset of lower extremity injuries (based on the Body_Part field). Comparisons were made between the 2 groups for the studied variables by calculating the lower extremity rate (lower extremity injury estimate/total injury estimate x 100, presented as a percentage). National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database. The CPSC considers an estimate unstable and potentially unreliable when the estimate is <1,200.[14]

Results

There were an estimated 13,264 cell phone-related lower extremity injuries while walking treated at US hospital EDs during 2000-2023; this represents 35.5% of the estimated 37,344 such injuries affecting all body parts. The affected lower extremity body part was 6,376 (48.1%) ankle, 3,107 (23.4%) knee, 1,897 (14.3%) foot, 1,413 (10.7%) lower leg, 435 (3.3%) toe, and 35 (0.3%) upper leg.

Table 1 shows the distribution of cell phone-related injuries while walking by the activity and mechanism of injury. Most of the injuries occurred while the patient was texting on or looking at a cell phone, and a lower proportion occurred while the patient was talking on a cell phone. Moreover, the lower extremity rate was higher for injuries that occurred while texting on or looking at a cell phone than while talking on a cell phone. The majority of injuries involved a fall, and the next most common mechanisms were hitting or being hit by another object followed by hitting or being hit by a vehicle. The lower extremity rate was higher for injuries that occurred from falls and hitting or being hit by a vehicle than for hitting or being hit by another object. For the estimated 852 lower extremity injuries that occurred by hitting or being hit by a vehicle, the type of vehicle was 739 (86.8%) automobile, truck, or motor vehicle (not otherwise stated); 57 (6.7%) motorcycle, moped, or dirt bike, and 55 (6.5%) train.

Table 2 presents the distribution of cell phone-related injuries while walking by the time period and the location of the incident. The estimated number of injuries increased during each 4-year period from 2000-2003 to 2016-2019 and then declined slightly during 2020-2023. Moreover, the lower extremity rate increased during 2000-2003 to 2008-2011 and then remained relatively stable for the rest of the study period. The estimated number of injuries did not vary greatly by season. Of those injuries with a documented location of incident, the highest proportion occurred at other public property. The next most reported location was home followed by street or highway; a small proportion of the injuries occurred at school. The lower extremity rate was lower for other public property and school than for home or street or highway.

When the patient demographics of cell phone-related injuries while walking were ex-

Table 2. Time period and location of incident of cell phone-related injuries while walking treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE rate (%)
	Estimate	%	Estimate	%	
4-year period					
2000-2003	34	0.3	275	0.7	12.2
2004-2007	337	2.5	1,166	3.1	28.9
2008-2011	1,390	10.5	3,674	9.8	37.8
2012-2015	2,646	19.9	7,810	20.9	33.9
2016-2019	4,477	33.8	12,413	33.2	36.1
2020-2023	4,381	33.0	12,004	32.1	36.5
3-month period					
December-February	3,285	24.8	8,743	23.4	37.6
March-May	2,953	22.3	8,980	24.0	32.9
June-August	3,481	26.2	9,146	24.5	38.1
September-November	3,547	26.7	10,475	28.0	33.9
Location of incident					
Other public property	3,653	27.5	12,309	33.0	29.7
Home	2,242	16.9	6,817	18.3	32.9
Street or highway	2,156	16.3	5,493	14.7	39.2
School	331	2.5	1,137	3.0	29.1
Place of recreation or sports	193	1.5	777	2.1	24.9
Industrial place	78	0.6	95	0.3	82.0
Not recorded	4,611	34.8	10,716	28.7	43.0
Total	**13,264**		**37,344**		**35.5**

Please see footnote in Table 1.

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amined (Table 3), relatively few of the patients were aged 0-12 years. Patients aged 13-39 years accounted for 69.1% of the estimated lower extremity injuries and 59.1% of the estimated total injuries. The lower extremity rate was higher for patients aged 6-49 years than for patients aged 50 years and older. Most of the patients were female, and the lower extremity rate was higher for females than for males.

Table 4 provides the distribution of cell phone-related injuries while walking by the type of injury (diagnosis) and patient disposition. For cell phone-related lower extremity injuries while walking, the most common type of injury was strain or sprain followed by fracture, contusion or abrasion, and laceration. For cell phone-related injuries while walking affecting all body parts, the most common type of injury was strain or sprain followed by contusion or abrasion, fracture, and laceration. The lower extremity rate was highest for strain or sprain and lowest for laceration. Most of the patients were treated or examined in the ED and released. There was 1 fatality case, resulting in a national estimate of 18 fatalities.

Discussion

Ninety-seven percent of people in the US own a cell phone.[1] Consequently, millions of people are at risk of cell phone-related injury, including when using or carrying a cell phone while walking.[2-4] Although a portion of these injuries may affect the lower extremity, literature on cell phone-related lower extremity injuries while walking is limited.

This study found that most of both lower extremity injuries and total injuries occurred while the patient was texting on or looking at a cellphone while a smaller proportion occurred while the patient was talking on a cell phone. Texting might be more distracting since the person usually has to look at the cell phone while texting. In contrast, a person usually can more easily observe their surroundings while talking on a cell phone. Another possible explanation for the lower proportion of injuries that occurred while the patient was talking on a cell phone could be that such cases might have been more likely to have been excluded from the study, particularly if the injury occurred at home. If the record Narrative stated that a person was talking on a phone while walking at home but did not state that phone was a cell phone, the record would not have been included in the analysis because the person could have been using a cordless landline phone. This would not have been the situation if the Narrative stated that a person was texting on or looking at a phone while walking at home but did not state that it was a cell phone because the phone would likely be a cell phone.

For both lower extremity injuries and total injuries, most of the injuries involved a fall followed by hitting or being hit by another object and hitting or being hit by a vehicle. However, the lower extremity rate was higher for injuries that occurred from falls and hitting or being hit by a vehicle than from hitting or being hit by another object. This suggests that the mechanisms differ in which body parts will likely experience injury, a factor which may need to be taken into consideration when creating prevention activities. Furthermore, the observation that the mechanisms differ in risk of lower extremity injuries might account for the difference in lower extremity rates observed among the subgroups of other examined factors. For example, the observation that the lower extremity rate was higher for injuries that occurred while texting on or looking at a cell phone than while talking on a cell phone could partially be due to differences in the mechanisms of injury between these two activities.

The estimated number of cell phone-related injuries while walking increased during 2000-2019 for both lower extremity injuries and total injuries. Other studies using NEISS data also observed an increase in the estimated number of cell phone-related injuries while walking.[2-4] This increase is likely due to an increase in the number of people owning cell phones.[1] Alternately, it may be that the hospital staff providing records to NEISS increasingly documented in the Narrative field that the injury was related to cell phone use or possession while walking. Interestingly, the estimated number of cell phone-related injuries while walking declined slightly during 2020-2023. This may be due to the number of cell phone owners increasing only slightly during this time period. The January 2024 Pew Research Center fact sheet indicates that the proportion of people in the US with cell phones increased from 62% in 2002 to 96% in 2019 but only further increased to 97% in 2023.[1] Alternately, in recent years, people may have become more aware of the hazards of using a cell phone while walking and become less likely to do so.

For both lower extremity injuries and total injuries, the highest proportion of cell phone-related injuries while walking occurred at other public property followed by home and street or highway. This indicates that such injuries don't occur primarily on the street but other places as well, even at home. That the lower extremity rate varied by the location of the incident suggests that the mechanism of the injuries may vary by location. That a small portion of the injuries occurred at school is important for several reasons. First, injuries that occur at school are likely to involve children, who may be at increased risk of certain injuries. Second, currently, there are efforts to reduce or eliminate cell phone use by students in school.[18] If the use of cell phones in school is reduced, then cell phone-related injuries in school also should decline.

For both lower extremity injuries and total injuries, the majority of patients were aged 13-39 years, and most patients were female. These results were similar to those reported by previous studies using NEISS data,[2-4] although one of the studies reported a higher proportion of the patients were male.[3] It may be that adolescents and younger adults and females are more likely to use or carry cell phones while walking. Alternately, people of this age and gender may be at increased risk of injury while using a cell phone while walking. In either event, prevention and education activities might need to target these demographic groups.

Cell phone-related injuries while walking affecting both the lower extremity and all body parts most often involved a sprain or strain with

Table 3. Patient demographics of cell phone-related injuries while walking treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE rate (%)
	Estimate	%	Estimate	%	
Patient age (years)					
0-5	5	0.0	461	1.2	1.0
6-12	469	3.5	1,106	3.0	42.5
13-19	3,141	23.7	7,554	20.2	41.6
20-29	3,098	23.4	8,386	22.5	36.9
30-39	2,927	22.1	6,118	16.4	47.8
40-49	1,882	14.2	5,205	13.9	36.2
50-59	888	6.7	3,605	9.7	24.6
60-69	550	4.2	2,594	6.9	21.2
70-79	135	1.0	1,636	4.4	8.2
80+	169	1.3	680	1.8	24.8
Patient gender					
Female	8,502	64.1	21,351	57.2	39.8
Male	4,762	35.9	15,993	42.8	29.8
Total	**13,264**		**37,344**		**35.5**

Please see footnote in Table 1.

contusion or abrasion and fracture being the next most common injury and laceration being the least common type of injury. Most patients with these types of injury might be expected to require less extensive medical care. This study found that most patients were treated or examined at the hospital ED and released. However, 3.0% of the patients experiencing lower extremity injuries and 3.9% experiencing total injuries were admitted for hospitalization, held for observation, or transferred to another hospital, and there was 1 reported fatality. Thus, although relatively uncommon, using or carrying a cell phone while walking can lead to injury requiring more extensive management or even death.

There are limitations to this study. The NEISS database does not have any way to easily identify cell phone-related injuries. To identify cases, first, all records where the product code for telephones or telephone accessories was used in any of the product code fields or "phone" was used in the Narrative field were identified. Then the Narrative field for each record was reviewed to determine whether the

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phone was a cell phone because either "cell" or some equivalent term was used or the context indicated that the phone was a cell phone and the activity was walking while using or carrying the cell phone. Any records where the patient was using or carrying a cell phone while walking and did not meet these criteria would not have been included in the analysis. Thus, the estimated number of injuries is likely to be an underestimate. As indicated previously, this is particularly true for records where the Narrative stated that the patient was talking on a phone (but not explicitly stating a cell phone) while walking at home because the phone could have been a cordless landline phone. Furthermore, the selection of records for inclusion in the study was made by a single person. In addition, the study included only patients treated at hospital EDs. Examination of patients treated elsewhere, such as at home or by a primary care physician, would provide a more complete understanding of injuries that occur while walking with a cell phone.

In conclusion, although the estimated number of cell phone-related lower extremity injuries while walking that were treated at US hospital EDs appears to have stabilized in recent years, it remains a problem. Such injuries most often occurred while the patient was texting on or looking at the cell phone, and the majority involved a fall. While the highest proportion of the injuries occurred at other public property, the next most common location was the home. The majority of patients were aged 13-39 years—the so-called digital natives, and most patients were female. The most common type of injury was strain or sprain followed by fracture, contusion or abrasion, and laceration. The results of this study may be useful for creating educational activities that can reduce the occurrence of these injuries. ler

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

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Table 4. Type of injury and patient disposition of cell phone-related injuries while walking treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE rate (%)
	Estimate	%	Estimate	%	
Type of injury (diagnosis)					
Strain or sprain	6.306	47.5	8.876	23.8	71.0
Contusion or abrasion	2.005	15.1	7.260	19.4	27.6
Fracture	2.226	16.8	5.751	15.4	38.7
Laceration	939	7.1	5.290	14.2	17.7
Other or not stated	1.790	13.5	10.166	27.2	17.6
Patient disposition					
Treated or examined at emergency department and released	12.627	95.2	35.222	94.3	35.8
Treated and admitted for hospitalization (within same facility)	370	2.8	1.210	3.2	30.5
Treated and transferred to another hospital	16	0.1	177	0.5	9.2
Held for observation (includes admitted for observation)	16	0.1	63	0.2	25.3
Left without being seen or left against medical advice	236	1.8	654	1.8	36.1
Fatality, including dead on arrival, died in the emergency department	0	0.0	18	0.0	0.0
Total	**13,264**		**37,344**		**35.5**

Please see footnote in Table 1.

Training on Unstable Surfaces Improves Balance Ability in Older Adults

By Alex Rizzato, Matteo Bozzato, Luca Rotundo, Giuseppe Zullo, Giuseppe De Vito, Antonio Paoli, and Giuseppe Marcolin

Posterior malleolus fractures have been associated with ankle instability because the ligament pull that follows such fractures can lead to movement of the fracture fragment and consequently disrupt the weight-bearing surface's integrity.

Falls are a multifactorial phenomenon and a cause of increasing rates of mortality and morbidity in older adults, and are significant contributors to disability or early institutionalization. An age-dependent decrease in postural balance control and a progressive loss of lower limb muscle strength have been addressed as crucial causes of the risk of falling. A growing amount of evidence has contended that a multidisciplinary approach is required to lower the incidence and consequences of falls, also outside geriatric contexts, and that falls in older adults can be prevented with appropriately tailored exercise programs.

Due to their practical benefits and widespread applications, there has been growing interest in using unstable devices in training protocols. This study aimed to assess the effectiveness of 2 multimodal exercise interventions (ie, on stable and unstable surfaces) on dynamic balance control and lower limb strength in older adults.

Methods

Sixty-two older adults, age 60–85 years, who were autonomous in activities of daily living, were randomly assigned to 2 intervention groups (N = 20, stable group; N = 19, unstable group), and to a control group (N = 18); 57 participants completed the study. In this single-blinded randomized controlled study, the 2 intervention groups underwent a 12-week training program twice a week for 45 minutes, consisting of strength and balance exercises. The stable (ST) group performed the training program over stable surfaces (Table 1), while the unstable (UNST) group over unstable surfaces (Table 2).

At the beginning of the study (T0), the Global Physical Activity Questionnaire (GPAQ-2) was administered to estimate the daily physical activity level, and the grip strength of the dominant hand was measured using a handgrip dynamometer. The dominant lower limb strength was evaluated in the 3 testing sessions through an isometric maximal voluntary contraction (MVC) of the quadriceps. In the Timed Up and Go (TUG) test, subjects were required to stand up from the chair, walk at the preferred pace to a cone at 3 meters, turn around, and walk back to the chair to sit down. In the 10-minute walking test, subjects were instructed to walk 20 meters at their preferred speed (Figure 1).

Dynamic balance was assessed by computing the center of pressure (CoP) trajectory while a driven movable platform induced an unexpected perturbation of the base of support. Specifi-

This article has been excerpted from "Multimodal training protocols on unstable rather than stable surfaces better improve dynamic balance ability in older adults. Eur Rev Aging Phys Act 21, 19 (2024). https://doi.org/10.1186/s11556-024-00353-8. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

Continued on page 57

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

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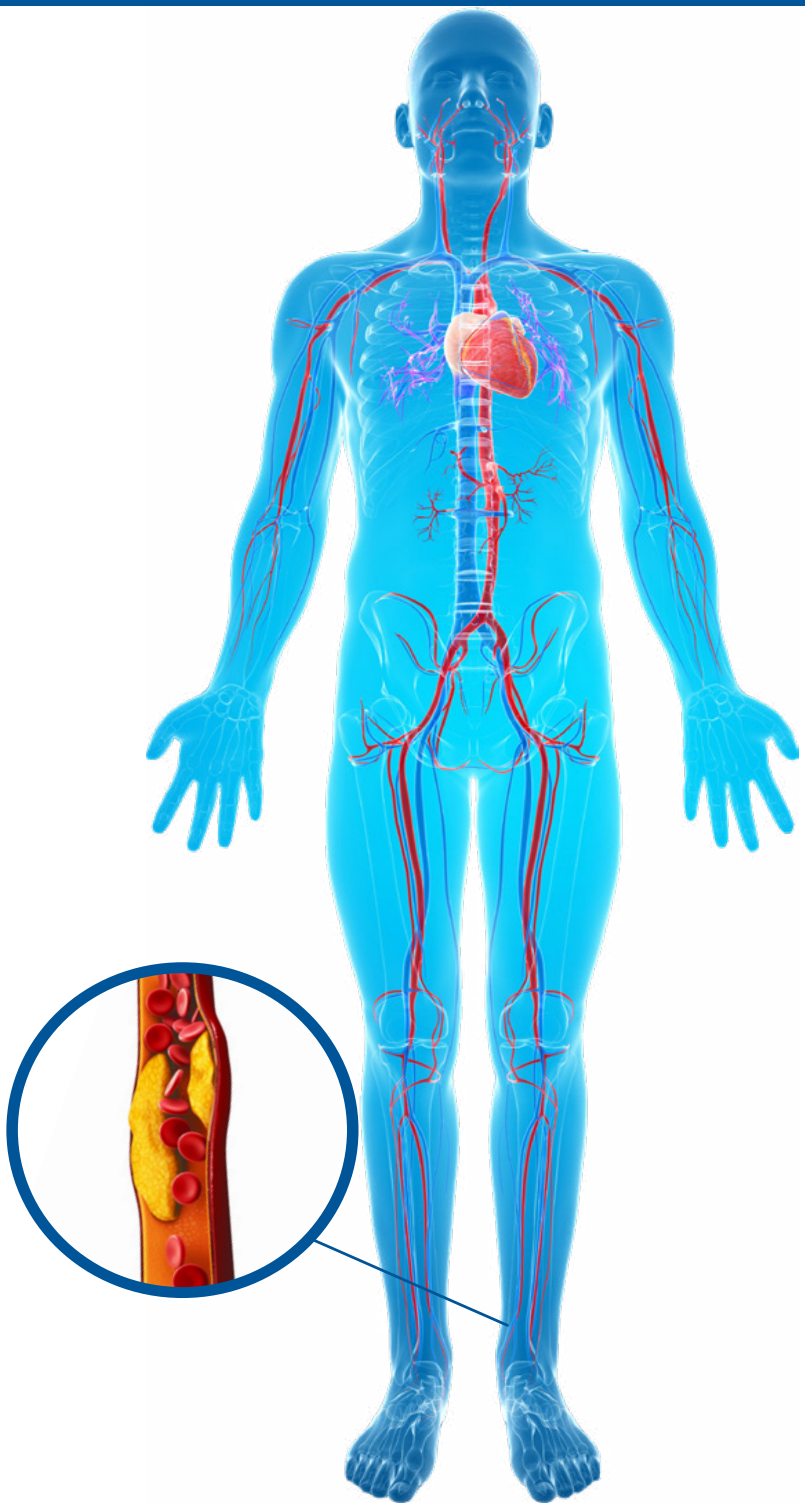

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Continued from page 54

Table 1. Training exercises and volume of the group training over stable surfaces (ST). EB elastic band, AB ankle brace.

STABLE GROUP (ST)					
Training A					
Exercise	**Training volume (series x reps)**	**Weeks 1–3**	**Weeks 4–6**	**Weeks 7–9**	**Weeks 10–12**
Standing hip abduction	3 × 10–15	No weights	EB	↑ EB resistance	↑ EB resistance no support
Hip flexion	3 × 10–15	Seated No weights	Seated AB (2 kg)	Standing AB (2 kg)	Standing AB (3 kg)
Monopodalic stance	3 × 30 s	No support	↑ volume (3 × 45 s)	Dual-task[a]	Dual-task[b]
Crunch	3 × 10–15	Knee-touch	Hands behind head	Hands behind head ↑ volume	Hands behind head ↑ volume
Squat	3 × 10–15	/	Half squat	Box squat	Squat
Training B					
Exercise	**Training volume (series x reps)**	**Weeks 1–3**	**Weeks 4–6**	**Weeks 7–9**	**Weeks 10–12**
Leg press	3 × 10–15	40% body mass	↑ load	↑ load	↑ load
Standing hip adduction	3 × 10–15	No weights	EB	↑ EB resistance	↑ EB resistance no support
Standing hip extension	3 × 10–15	No weights	AB (2 kg)	AB (3 kg)	AB (3 kg) no support
Calf	3 × 10–15	Bipodalic	Bipodalic no support	Monopodalic	Monopodalic no support
Bridge	3 × 30-45 s	/	Isometric	↑ volume	Dynamic (3 × 10–15 reps)

[a]Arms abducted holding a ball (2 kg) in a static position

[b]Upper limbs movements passing a ball from one hand to the other

cally, the study authors considered the following CoP-related parameters within a 2.5-second temporal window from the beginning of the perturbation: displacement (Area95), mean velocity (Unit Path), anterior–posterior first peak (FP), post perturbation variability (PPV), and maximal oscillations (ΔCoPMax). The dominant quadriceps strength was measured through an isometric MVC on an instrumented chair.

Results

Four out of 5 CoP-related parameters (ie, Area95, Unit Path, ΔCoPMax, and PPV) significantly improved in the UNST group from a minimum of 14.28% (d = 0.44) to a maximum of 52.82% (d = 0.58). The ST group significantly improved only in 2 (ie, ΔCoPMax, and PPV) out of 5 CoP-related parameters with an enhancement of 12.48% (d = 0.68) and 19.10% (d = 1.06). Both intervention groups increased the maximal isometric quadriceps strength (UNST:17.27%, d = 0.69; ST:22.29%, d = 0.98). The control group did not show changes in any of the parameters considered.

Discussion

The present study evaluated the effectiveness of 2 multimodal interventions in older adults, different for the surface where lower limb strength and balance exercises occurred: stable and unstable surfaces for ST and UNST groups, respectively. Both exercise interventions presented in this study improved lower limb strength and dynamic balance at 12 weeks. In detail, the training on unstable surfaces highlighted a better balance performance (ie, lower values of Area95) and a higher efficiency of the postural control systems (ie, lower values of Unit Path) in coping with the external perturbations superimposed by the electrically-driven movable platform. Moreover, although the dynamic balance improvements (Table 3) in both intervention groups were significantly greater compared to the control group, effect sizes were higher in the UNST (Cohen's d from 0.44 to 1.21) rather than in the ST (Cohen's d from 0.06 to 1.06) group.

These findings support multimodal training on unstable surfaces as an effective choice to improve dynamic balance control in older adults. The main mechanism underpinning the overall better balance performance of the UNST group could be attributed to the stimuli the unstable surfaces gave the participants. Indeed, the induced instability could have introduced repeated changes in acting forces and unpredictable sensory inputs that highly stimulated the proprioceptive system. In this regard, the training protocol on unstable surfaces could have improved the demand on the nervous system to perceive sensory signals and generate appropriate motor commands. Conversely, the less striking improvements in dynamic balance control in the ST group could be attributable to the control mechanisms of the CoP displacement within the base of support that is related more to sensory perception than to muscle strength.

Overall, in a dynamic environment, CoP-related parameters are more sensitive than functional test outputs in the balance scoring process, reducing the risk of not highlighting training advancements. Indeed, the employment of an electrically driven movable platform and the specific CoP-related parameters represented a novelty in this longitudinal study. The FP reflects the efficacy of the earliest feet-in-place

Continued on page 58

Continued from page 57

Table 2. Training exercises and volume of the group training over unstable surfaces (UNST). EB elastic band, AB ankle brace.

UNSTABLE GROUP (UNST)					
Training C					
Exercise	**Training volume (series x reps)**	**Weeks 1–3**	**Weeks 4–6**	**Weeks 7–9**	**Weeks 10–12**
Standing hip abduction	3 × 10–15	On foam pad	On foam pad + EB	On balance disc ↑ EB resistance	On balance disc + EB no support
Hip flexion	3 × 10–15	On gymnastic ball	On gymnastic ball + AB (2 kg)	On gymnastic ball + AB (3 kg)	On gymnastic ball + AB (3 kg) no support
Monopodalic stance	3 × 30-45 s	On foam pad	On balance disc	On balance disc ↑ volume	On balance disc no support
Crunch	3 × 10–15	On gymnastic ball hands on chest	On gymnastic ball hands behind head	On gymnastic ball ↑ volume	On gymnastic ball ↑ volume
Squat	3 × 10–15	/	On foam pad half squat	On foam pad box squat	On balance disc box squat
Training D					
Exercise	**Training volume (series x reps)**	**Weeks 1–3**	**Weeks 4–6**	**Weeks 7–9**	**Weeks 10–12**
Leg press	3 × 10–15	On foam pad 40% body mass	On foam pad ↑ load	On balance disc ↑ load	On balance disc ↑ load
Standing hip adduction	3 × 10–15	On foam pad no weights	On foam pad + EB	On balance disc ↑ EB resistance	On balance disc + EB no support
Standing hip extension	3 × 10–15	On foam pad no weights	On foam pad + AB (2 kg)	On balance disc + AB (3 kg)	On balance disc + AB (3 kg) no support
Bipodalic calf	3 × 10–15	On foam pad	On foam pad no support	On balance disc	On balance disc no support
Bridge	3 × 30-45 s	/	On foam pad isometric	On foam pad ↑ volume	Dynamic on balance disc (3 × 10-15 reps)

postural responses to the perturbation of the base of support and depends mainly on the spinal cord-mediated stretch reflexes with the shortest latencies (< 70 ms). The non-significant changes of FP over the 12 weeks in both ST and UNST groups could depend on the training modalities that did not include exercises with sudden unexpected perturbations. Conversely, voluntary responses have more prolonged latencies (> 150 ms) and produce highly variable motor responses. Since most of the dynamic CoP-related parameters calculated (ie, Area95, Unit Path, ΔCoPMax, and PPV) assessed postural responses with latencies longer than 150 ms, the study authors speculate that exercises of both interventions (Tables 1 and 2) trained mainly voluntary controlled mechanisms.

Moreover, unlike previous studies, the exercises in this multimodal training programs differed completely from the dynamic balance test performed over the electrically driven movable platform. Consequently, in agreement with Bierbaum and colleagues, these findings provide indirect evidence that both multimodal training protocols produced motor and perceptive schemes useful outside of the specific training domain. It has been argued that new postural strategies may be ascribed to a shift from prefrontal activity to a subcortical circuit, accompanied by increased automatic balance performance. Considering the higher balance improvements of the UNST group, the study authors speculate that repetitive training with unstable devices could boost sensorimotor adaptations transferable to daily living postural control. Indeed, the repeated exercises proposed with the unstable training protocol enhanced balance skills not only within the same repeated exercises but also in other untrained demanding balance tasks (ie, responding to a sudden perturbation of the base of support). Hence, the multimodal training protocol over unstable

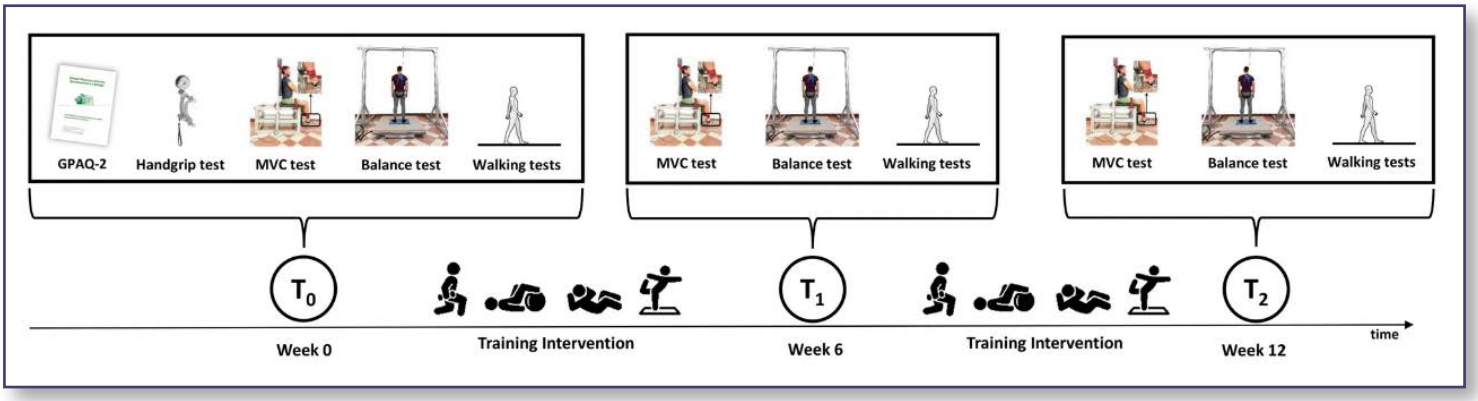

Figure 1. Overview of the experimental design. T0, T1 and T2 represent the time points of the assessments within the 12-week interventions.

Table 3. T0 to T2 differences in percentage (Δ%) of the outcome parameters together with the correspondent effect size values (Cohen's d).

	ST		UNST		CTRL	
	Δ% (T_2-T_0)	*Cohen's d*	Δ% (T_2-T_0)	*Cohen's d*	Δ% (T_2-T_0)	*Cohen's d*
Unit Path ($cm \cdot s^{-1}$)	-2.16	0.19	-14.28	0.44	-4.46	0.25
Area95 (cm^2)	-29.64	0.41	-52.82	0.58	-35.96	0.54
First Peak (cm)	0.73	0.06	-7.37	0.72	3.12	0.24
ΔCoPMax (cm)	-12.48	0.68	-21.21	1.10	-6.29	0.31
PPV (cm)	-19.10	1.06	-25.75	1.21	-14.84	0.68
Strength (%BM)	22.29	0.98	17.27	0.69	0.46	0.02
TUG (s)	-4.99	0.53	-5.78	0.54	-4.31	0.24
10-m (s)	-2.02	0.20	-1.39	0.17	-0.24	0.01

surfaces could supposedly help minimize the risk of falls in older adults.

Although the 2 interventions presented in this study were not fully oriented to increase strength, they showed improvements (Table 3) in the quadriceps isometric strength compared to the control group. After 6 weeks, the isometric strength of knee extensors significantly increased only in the ST group, which maintained this improvement until week 12. Conversely, the unstable training did not trigger a strength increase at the early stage and exhibited nearly similar increases to the stable training only at week 12. Thus, both multimodal trainings led to similar enhancement in lower limb strength over the 12 weeks. However, the different training surfaces used by the 2 intervention groups could account for the earlier strength enhancement in the ST group. Although the perceived exertion was the same for the 2 groups, strength exercises of the UNST group did not allow the same load progressions over the 12 weeks compared to the ST group (mean load: ~ -20%). Indeed, given the need for continuous adaptation to unstable surfaces, exercising with unstable devices might cause reduced force production during training. Overall, strength increments detected in UNST and ST were moderate compared to those following protocols oriented to resistance training, namely ~ 35% [41] and ~ 37% [42]. However, they were in line with increments of similar studies using multimodal exercise protocols on stable surfaces: ~ 20% [43], ~ 20% [10], and ~ 19%. Notably, the mentioned studies were performed on highly deconditioned subjects. Indeed, institutionalized older adults, considering their functional loss, could obtain more significant functional gains following multimodal training (ie, strength, mobility, and balance) compared to healthy, active older adults. Hence, the results of this study expands previous findings in deconditioned subjects, demonstrating that multimodal training protocols based on balance and strength exercises also positively affected strength in active older adults.

Finally, although dynamic balance control and lower limb isometric strength increased after training, the functional walking tests showed no improvements during and after the training interventions. Even though these tests are valid and reliable in assessing health-related physical fitness, these findings could be explained by the ceiling effect these tests presented when applied in high-functioning older adults.

Conclusions

The 2 multimodal training programs increased muscular strength and dynamic balance control at 12 weeks. Stable surfaces promoted faster increments of muscular strength. Unstable surfaces were more effective in enhancing dynamic balance efficiency. These findings suggested the employment of multimodal training on unstable rather than stable surfaces to potentially lower the incidence of falls in older adults. ler

Alex Rizzato, PhD, temporary researcher; Matteo Bozzato, research fellow; Luca Rotundo; Giuseppe De Vito, MD, PhD, professor of human physiology; Antonio Paoli, professor and chair of sport and exercise sciences, director of the Nutrition & Exercise Physiology Laboratory; and Giuseppe Marcolin, assistant professor, are with the Department of Biomedical Sciences, University of Padova, Italy.

Giuseppe Zullo, is a research fellow with the Department of Industrial Engineering, University of Padova, Italy.as

Falls are a multifactorial phenomenon and a cause of increasing rates of mortality and morbidity in older adults, and are significant contributors to disability or early institutionalization.

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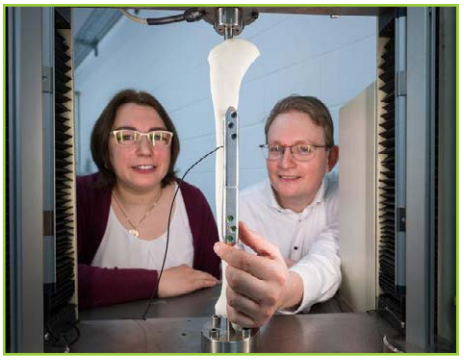
MICRO-MASSAGING ARTIFICIAL MUSCLES HELP FRACTURED LEG BONES HEAL BETTER

An interdisciplinary team of medical specialists, engineers, and computer scientists at Saarland University, Saarbrücken, Germany, are developing smart implants that can continuously monitor and actively promote bone healing—by, for example, micro-massaging the fracture site. The team of engineers led by Stefan Seelecke, Prof. Dr.-Ing., iMSL, chair of intelligent material systems and Paul Motzki, Prof. Dr., chair of smart material systems for innovative production, have equipped the implant with smart "artificial muscles." Fabricated from shape memory wires, these muscles provide a way to control the fracture repair process via smartphone.

As soon as the fixation plate has been attached and the wound sutured, the implant begins providing a continuous stream of information on how the fracture is healing. If the patient puts too much pressure on the fracture, the smart implant will give a warning. At the fracture gap, where the bone fragments have been realigned with each other, the implant can be made more or less rigid as required; it can even undergo tiny motions to deliver a micro-massage to the fracture site. This kind of "micro-manipulation" at the surface of the bone actively promotes healing by stimulating growth. And these processes can all be fully automated using a smartphone.



Doctoral research students Susanne-Marie Kirsch (l.) and Felix Welsch (r.) are working on the prototype implant.

Ultrafine nickel-titanium "shape memory" wires are used as mechanical actuators that can alter the local rigidity of the implant and make it move or exert a force. They also are used as sensors to monitor processes taking place at the fracture site. The wires can contract or relax like real muscle fibers depending on whether an electric current is flowing or not. The engineers fabricated bundles of these wires, just as muscle fibers are grouped into bundles. By alternately tensing and relaxing the wires, the engineers can simulate the movement of flexor or extensor muscles. The wires are able to exert a substantial force over a very short distance. These artificial muscles also have their own intrinsic sensor properties. When the wires change shape, so does their electrical resistance, allowing the researchers to precisely assign resistance values to even the smallest of deformations, which allows them to extract sensory data. The data allow the team to monitor minute changes occurring in the gap between the bone fragments. This close monitoring of the fracture gap enables the medical team to assess whether fracture site stiffness increases over time. By careful data modelling and programming, the researchers are able to choreograph highly precise motion sequences for the fixation plate to perform. In the future, this sensor data will be transmitted wirelessly to a smartphone.

These electrically responsive fibers can be positioned above the fracture site. Electrical signals can then be applied to control whether the artificial muscles fibers elongate, contract, or remain unchanged, thus determining the local rigidity of the fixation plate at the fracture site. The researchers can control the artificial muscles that span the fracture gap so that they expand and contract at the required frequency. Due to their intrinsic sensor properties, these bundles of shape memory wires also serve as the implant's nervous system. If it becomes harder to contract the artificial muscles positioned across the fracture gap, this is a good indication that the bone tissue in this region is becoming harder and the healing process is progressing. The system is controlled by a semiconductor chip. Once in place, the implants can be left do their work. Even charging is carried out remotely: "The implant will be fitted with a powerful battery that can be recharged in situ via wireless induction," said Motzki.

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UD RESEARCHERS DEVELOPING FORCE-SENSING DEVICES FOR PROSTHETIC LEGS

John Horne lost his right leg to bone cancer when he was a freshman in high school. This personal experience spawned his career and passion for advocating for those with limb loss. The president of Independence Prosthetics-Orthotics on the University of Delaware's (UD) Science, Technology, and Advanced Research (STAR) Campus has seen prostheses improve significantly since his limb loss and since he was an undergraduate student at UD, interning at Nemours Children's Health, where he poured prosthetic molds.

Now, Horne is part of pioneering research led by George W. Laird Professor of Mechanical Engineering Jill Higginson, PhD, in the Neuromuscular Biomechanics Laboratory along with co-investigators Elisa Arch, PhD, associate professor of kinesiology and applied physiology, and Meg Sions, DPT, PhD, associate professor of physical therapy, in the College of Health Sciences. The study aims to test the potential of fabric-based sensors in monitoring load in individuals with limb loss.

"By monitoring limb loads in individuals with lower limb amputation, we can determine whether they're loading symmetrically or overloading over time to ensure they're using their limb optimally," Higginson said. "Wearable technology like these sensors can help us monitor loads and gauge performance in the real world."

John Horne (center) walks with a fabric-based sensor in his prosthetic in UD's Neuromuscular Biomechanics Laboratory while George W. Laird Professor of Mechanical Engineering Jill Higginson (right) and biomedical engineering doctoral student Theophilus Annan test whether the sensor can monitor lead in individuals with limb loss.

These innovative sensors were developed by Erik Thostenson, PhD, professor of mechanical engineering in the College of Engineering; and Sagar Doshi, PhD, an associate scientist in UD's Center for Composite Materials; and Higginson.

Horne first experienced force-sensing devices in an orthopedic boot for people with Achilles tendon rupture as part of a senior design project in Higginson's lab several years ago and identified an unmet need in the limb loss community. "The difference between the socket and the foot in a prosthetic pylon is an area that functionally we haven't taken advantage of until now," he said.

Horne demonstrated that the ongoing study requires placing the small sensors in the pylon of his prosthesis. He then walked on a treadmill with force plates in the motion capture lab to gauge whether the treadmill data mirrored the sensor data.

"The conversation, clinically with patients, has always been tough to translate what the patient is feeling," Horne said. "A device like this gives us hardcore data so clinicians can directly understand what's happening and make changes," said Horne. It could also help patients who lack access to healthcare. "The device could generate data from patients in rural areas who may be having prosthetic issues, and we can adjust without them being on-site," he said.

"Right now, the only time we know if something is wrong with a person's prosthetic is when they're in pain," said Hanna Armstrong, an honors student who graduated from UD in May with her bachelor's degree in biomedical engineering and has worked in Higginson's lab since high school . "These pressure sensors stand to change what rehabilitation looks like for people with limb loss." So far, it's working, she said.

LOWER LIMB EXOSKELETON DESIGNED FOR PATIENTS WITH REDUCED OR ABSENT MOBILITY

TWIN is a new robotic exoskeleton for lower limbs, designed and developed by Rehab Technologies IIT – INAIL, the joint laboratory between the Istituto Italiano di Tecnologia (IIT, Italian Institute of Technology) and the Prosthetic Center of INAIL (the prosthetic unit of the National Institute for Insurance against Accidents at Work). The motorized exoskeleton is an external structure capable of enhancing

the physical abilities of the wearer. It has been designed to allow individuals with reduced or even absent motor abilities in the lower limbs, such as in cases of complete spinal cord injuries, to maintain an upright position, walk with the assistance of crutches or walkers, and to stand up and sit down.

Two features make TWIN unique in the world: it is made of lightweight materials, such as aluminum alloy, and it is composed of modular components, facilitating usability and transportation. Image courtesy of IIT-Istituto Italiano di Tecnologia.

Two features contribute to the uniqueness of the device: it is made of lightweight materials, such as aluminum alloy, and it is composed of modular components, facilitating usability and transportation. Furthermore, the structure is adjustable based on the patient's physical characteristics through telescopic links placed at the level of the femur and tibia. Ankle and foot supports are available in various sizes to adapt to the ergonomics of the user. TWIN's operating modes are also adaptable to the patient, evaluating the degree of motor deficit of the person wearing it, particularly their ability to perform autonomous walking.

The exoskeleton can be controlled by an operator, such as a physiotherapist, using a specific Android application installed on the provided tablet. The graphical interface allows for controlling the exoskeleton in the execution of various programed activities, setting the kinematic parameters of movement, and choosing between different step execution modes.

The exoskeleton works in 3 operating modes: Walk mode is designed for patients with absent motor function; the exoskeleton imposes a walking pattern according to programed parameters. Retrain mode is used for patients with partial impairment of lower limb motor function, capable of performing a more or less autonomous movement but with difficulty in some phases of the step—in this case, the exoskeleton supports the patient's movement with more or less intensity, directing them toward an optimal reference trajectory. TwinCare mode is designed for patients with partial and differentiated motor impairment between the 2 limbs, where 1 leg is healthy and can move autonomously, while the other requires assistance, more or less pronounced, in some phases of the step.

The motors activate the knee and hip joints, imposing a completely configurable movement pattern on the patient's limbs, in terms of step length and type, and walking speed. The battery has a lifespan of about 4 hours and requires an hour to recharge.

In addition to rehabilitation clinics during physiotherapy sessions, TWIN can be worn daily, even for just a few hours, as assuming the upright position brings significant benefits in terms of musculoskeletal, circulatory, psychological, and digestive system functionality for wheelchair users.

OA KNEE BRACE

DonJoy® ROAM™ OA knee brace was designed to unload the pressure of unicompartmental osteoarthritis (OA) and shift weight away from the affected knee to relieve pain and improve stability and mobility. Designed for conservative care and for pre- and post-operative knee protection, the brace is ideal for a wide range of patients who want to maintain or increase activity. Magnetic clips help align the strap connection points while "Set-and-Forget" technology allows patients to don and doff the brace without changing provider settings. The BOA® Fit System lets patients adjust support and pain relief on demand. The slim profile hinge design allows the brace to be worn beneath clothing. Dynamic strapping and unique condyle harness completely avoid sensitive skin in the popliteal space, while providing comfortable pressure to activate proprioception on the opposite side of the knee with maximal unloading during extension. Soft silicone keeps the brace comfortably in place.

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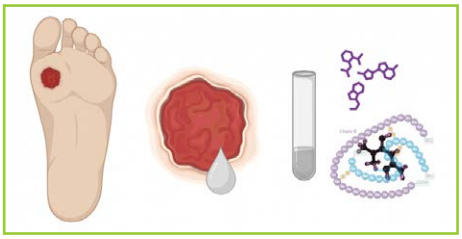
COMBINATION OF DIABETES DRUGS SHOW PROMISE FOR HEALING DFUS

People with chronic diabetic foot ulcers (DFUs) could soon have a new way to treat their wounds for faster healing and fewer hospital stays. Researchers from Michigan State University (MSU) and South Shore Hospital in South Weymouth, Massachusetts, have found that the combination of 2 common diabetes drugs—injectable insulin and orally-administered metformin—increases the amount of metformin at the wound site. As metformin can accelerate wound healing, this could be welcome news for the 18.6 million people worldwide who develop a DFU in their lifetimes. The team's findings may have immediate relevance to healthcare professionals treating patients with DFUs and biotech developers of wound dressings.

"We collected human exudates from diabetic foot ulcers and analyzed their composition," said Morteza Mahmoudi, PhD, an associate professor in the Department of Radiology and Precision Health Program in the MSU College of Human Medicine. "One of the things that we noticed in the composition of the exudates—which has not been observed anywhere else—was the presence of metformin.

"Until now, pharmacological studies had not found an interaction between insulin and metformin," he added. "Our study shows that

there could be at least an indirect role of consuming both insulin and metformin in a way that metformin can end up in a wound area where it enhances the body's capacity to heal."



Exudates from diabetic foot ulcers are found to contain molecules and pharmaceuticals such as metformin that are known to influence the wound healing process. Image courtesy of Mahmoudi.

The team, which includes co-researcher Lisa Gould, MD, PhD, a plastic surgeon and wound care clinician at South Shore Hospital and a clinical associate professor of medicine at Brown University, Providence, Rhode Island, received funding for their work from the National Institute of Diabetes and Digestive and Kidney Diseases.

"Our findings can affect the way that clinicians approach healing chronic wounds," Mahmoudi said. "For example, if a patient gets a wound, the synergistic role of insulin and metformin could be helpful. Additionally, wound dressing developers need to consider the interactions of anything they put on top of wounds with exudates," he continued. "Exudates can interact with the wound dressings and affect their safety and therapeutic efficacy. Additional research will be evaluating this."

RESEARCHERS INTRODUCE PROGRAMMABLE MATERIALS TO HELP HEAL BROKEN BONES

Natural materials like bone, bird feathers, and wood have an intelligent approach to physical stress distribution, despite their irregular architectures. However, the relationship between stress modulation and their structures has remained elusive. A new study that integrates machine learning, optimization, 3D printing, and stress experiments allowed engineers to gain insight into these natural wonders by developing a material that replicates the functionalities of human bone for orthopedic femur restoration; conventional methods of repairing a fractured femur typically involve surgical procedures to attach a metal plate around the fracture with screws, which may cause loosening, chronic pain and further injury.

The study, led by University of Illinois Urbana-Champaign civil and environmental engineering professor X. Shelly Zhang, PhD, and graduate student Yingqi Jia in collaboration with professor Ke Liu, PhD, from Peking University, Beijing, China, introduces a new approach to orthopedic repair that uses a fully controllable computational framework to produce a material that mimics bone.

University of Illinois Urbana-Champaign researchers show their 3D-printed resin prototype of the new bio-inspired material, here attached to a synthetic model of a fractured human femur. Image courtesy of Fred Zwicky.

"We started with materials database and used a virtual growth stimulator and machine learning algorithms to generate a virtual material, then learn the relationship between its structure and physical properties," Zhang said. "What separates this work from past studies is that we took things a step further by developing a computational optimization algorithm to maximize both the architecture and stress distribution we can control."

In the lab, Zhang's team used 3D printing to fabricate a full-scale resin prototype of the new bio-inspired material and attached it to a synthetic model of a fractured human femur. "Having a tangible model allowed us to run real-world measurements, test its efficacy and confirm that it is possible to grow a synthetic material in a way analogous to how biological systems are built," Zhang said. "We envision this work helping to build materials that will stimulate bone repair by providing optimized support and protection from external forces."

Zhang said this technique can be applied to various biological implants wherever stress manipulation is needed. "The method itself is quite general and can be applied to different types of materials such like metals, polymers—virtually any type of material," she said. "The key is the geometry, local architecture, and the corresponding mechanical properties, making applications almost endless."

REVITALIGN ELEVATED ESSENTIALS COLLECTION

Waco Shoe Company recently introduced the Revitalign® Elevated Essentials collection, which features the Laurel, Malibu penny, and Maple Mary Jane loafers, each designed to seamlessly blend style with orthotic-grade support. This loafer collection is more than a fashion statement—it's a step forward in comfort technology. The Revitalign® EVA and TPU cradled footbed, treated with Ultra-Fresh antimicrobials, helps control odor-causing bacteria, ensuring freshness with every wear. The removable insole, orthotic arch support, and deep heel cupping offer unparalleled comfort, while the Full Contact Comfort® technology, complete with a metatarsal pad, ensures all-day support. Malibu penny loafer features a suede upper, elastic stretch panels, and a penny loafer design accented with decorative stitching. Maple Mary Jane loafer stands out with its lugged outsole and dual strap design and is available in corduroy, genuine nubuck or patent leather. Laurel chunky loafer with gold chain embellishment was released in early 2024.

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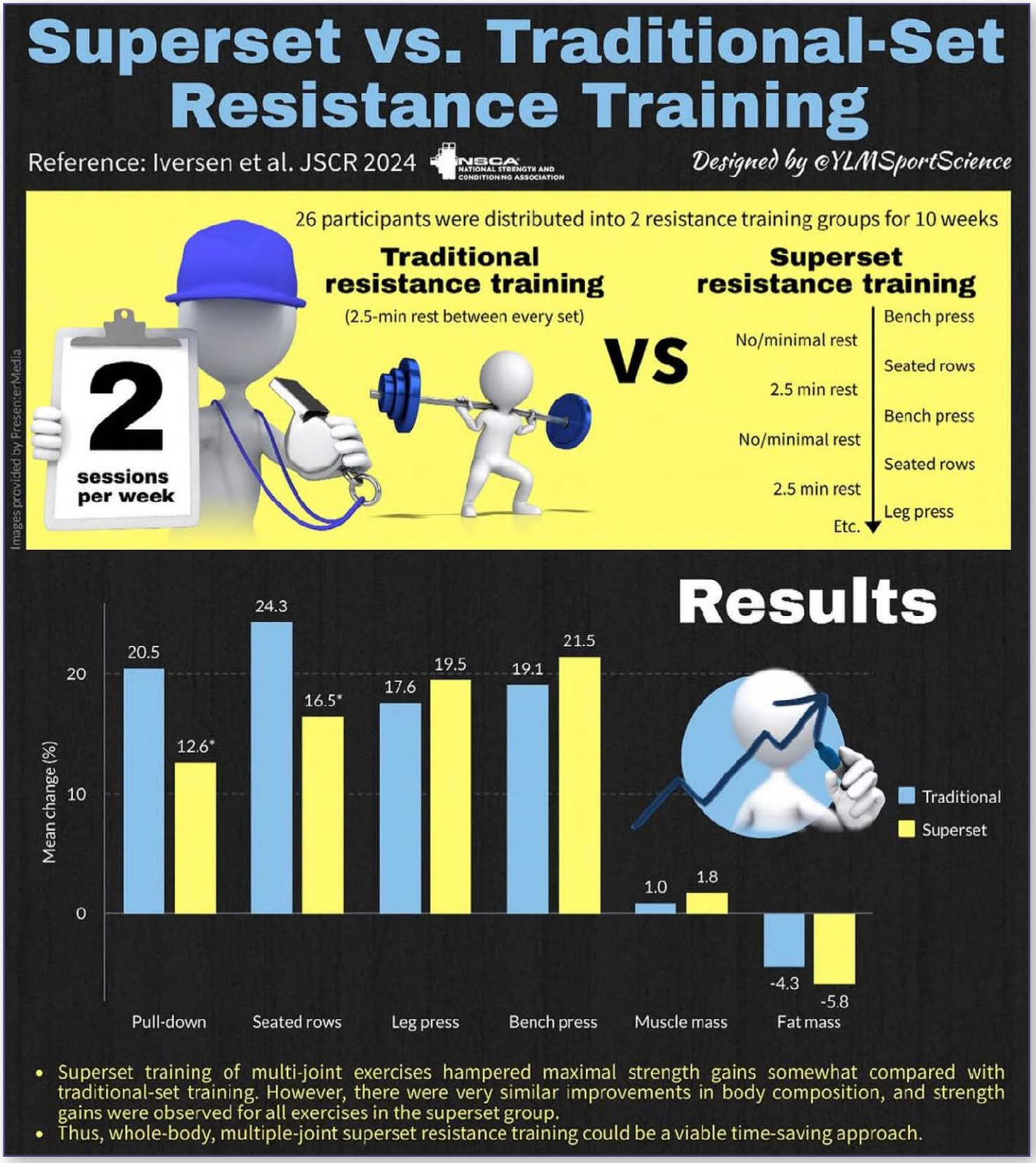

Source: Iversen VM, Eide VB, Unhjem BJ, Fimland MS. Efficacy of Supersets Versus Traditional Sets in Whole-Body Multiple-Joint Resistance Training: A Randomized Controlled Trial. Journal of Strength and Conditioning Research. 2024;38(8):p 1372-1378. DOI: 10.1519/JSC.0000000000004819

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