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LOWER EXTREMITY REVIEW

April 23 / volume 15 / number 4

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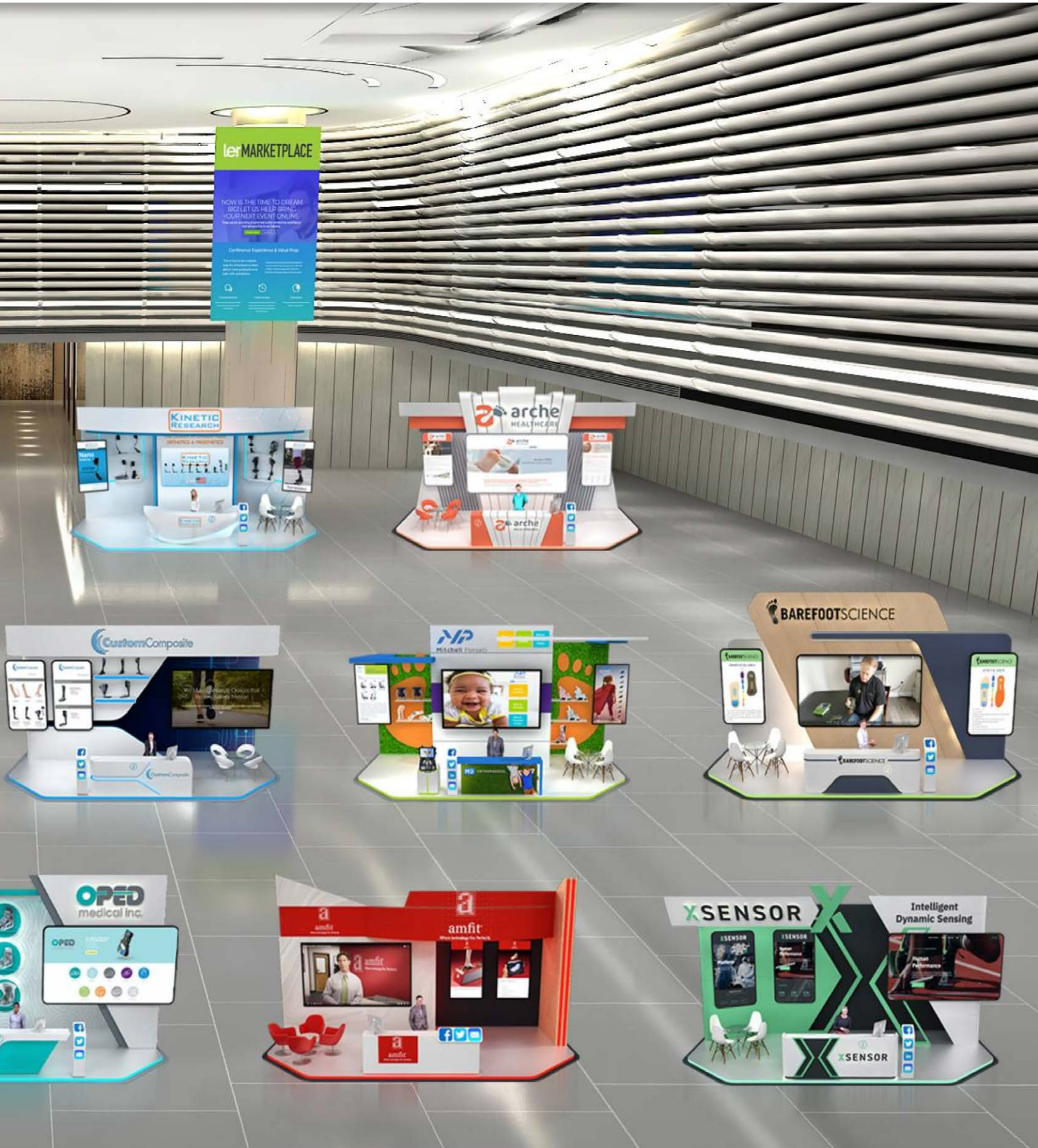

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Lower Extremity Review informs healthcare practitioners on current developments in the diagnosis, treatment, and prevention of lower extremity injuries. LER encourages a collaborative multidisciplinary clinical approach with an emphasis on functional outcomes and evidence-based medicine. LER is published monthly, except for a combined November/December issue and an additional special issue in December, by Lower Extremity Review, LLC.

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Lower Extremity Review Mission

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

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

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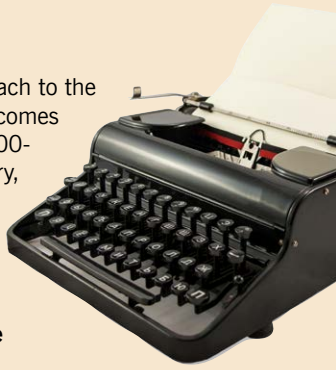

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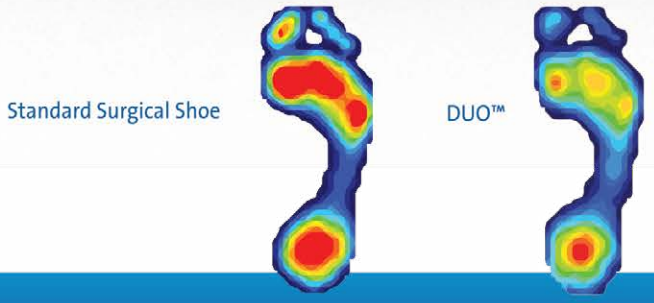

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Guest **Perspective**

The Hijacking of Exercise

By Greg Mack, ACE-CMES, RTSm, ACE-CPT

I have been involved in exercise personally and professionally since I was in grade school.

My introduction to exercise was initially through sports.

I remember doing the President's Council on Physical Fitness assessments while in grade school in the late 1960's. (I know, I know – I'm getting old). For those readers as ancient as I, can you remember those tests?

- Max pull-ups
- V-sit-and-reach
- Sit-ups (one minute)
- 30-foot shuttle run
- One-mile run

There were comparisons for each test that placed the individual in some percentile of a normative value system. This set of supposed tests of fitness were the standard in schools for decades. They underwent some changes in the 80's and I think are now known as "Let's Move."

The idea that fitness is attached to some performance standard is alive and well. In the modern philosophy of exercise process, known as "functionalism", the exercise and fitness enthusiasts are all considered "athletes." This notion of exercise being an athletic endeavor, and that all exercisers are treated as (and should consider themselves) athletes, dominates the fitness – and even physical therapy – landscape.

I think sports has hijacked exercise.

I think this is a mistake.

Now, don't get me wrong. I understand and support that athletic individuals participating in sports need to exercise. I understand that athletes working to achieve high levels of physical capabilities use the exercise process in ways that a non-athlete might never even consider, let alone need, to achieve a modicum of fitness. But, athletes seem to accumulate physical injury. When the exercise process expects the exerciser to push their limits in order to squeeze out ever-increasing physical performance feats, an injury is not far behind. Getting injured using exercise for general fitness is not fitness. Why would a non-athlete want to pursue exercise under these conditions?

This kind of "exercise" – which is more about physical movement – is something we should all be encouraging.

It sometimes seems as if the modern message of "everyone is an athlete" coming from the exercise and fitness community to the general population, most of which are not athletes and have no interest in sports, dissuades the non-athlete from pursuing exercise. The images used to promote exercise are composed of athletes pushing their physical limits and expressing the pain and discomfort that comes with that pursuit. This can be intimidating to the non-athlete. The exercise processes used to exercise individuals under the "everyone is an athlete" paradigm are high risk and unnecessary for general fitness and wellness.

My thesis is this: The message and delivery of exercise and fitness as an athletic endeavor complicates the already difficult process of getting more individuals to start and maintain an appropriate lifelong exercise process that achieves the powerful benefits regular exercise can bestow. Here regular exercise means basic physical activity, getting the body moving. For LER readers, it translates to Movement is essential.

My answer is this: The modern message needs to be more balanced in order to avoid stereotyping exercise as only for those that are athletically inclined. One that presents images of average everyday folks moving their bodies and enjoying non-athletic physical pursuits. It is our responsibility as exercise and healthcare providers to stimulate and inspire more of the general population to engage in a regular and reasonable process of exercise. One that does not tell them that they have to be an athlete, nor will be treated like one during exercise whether they like it not. Let's create messaging that encourages and exhorts participation in all types of movement at all levels for all classes. Let's move away from just offering a protocol based athletic exercise process. Let's customize the process to not just the client's

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physical needs but their mental perspective of self and how they want to experience movement and exercise. ler

Greg Mack is a gold-certified ACE Medical Exercise Specialist and an ACE Certified Personal Trainer. He is the founder and CEO of the corporation Fitness Opportunities. Inc. dba as Physicians Fitness and Exercise Professional Education. He is also a founding partner in the Muscle System Consortia. Greg has operated out of chiropractic clinics, outpatient physical therapy clinics, a community hospital, large gyms and health clubs, as well as operating private studios. His experience in working in such diverse venues enhanced his awareness of the wide gulf that exists between the medical community and fitness facilities, particularly for those individuals trying to recover from, and manage, a diagnosed disease. (http://www.physicians tness.com/) (http://www.exerciseproed.com/) (http://www.musclesystemconsortia.com/). This article is an update from Mack's entry on the blog for the Medfitness Network, one of LER's partners.

Benefits of Physical Activity

In its 2018 report, the Physical Activity Guidelines Advisory Committee found robust evidence to show that:

- There is a dose-response relationship between sedentary behavior (SB) and all-cause and cardiovascular disease (CVD) mortality risk, as well as a direct relationship with CVD, type 2 diabetes (T2D), and certain cancers. However, the risk associated with SB can be attenuated with greater amounts of moderate-to-vigorous physical activity (MVPA).
- PA lowers weight and fat gain and is associated with better bone health, even in children as young as 3 years.
- In older adults, multicomponent PA reduces risk of fall-related injuries; aerobic and multicomponent PA and balance activities improve physical function in the general population, as well as in those with frailty or other chronic conditions.
- Regular PA helps reduce the incidence of hypertension.
- Both the risk of Type 2 Diabetes and the risk of its progression to severe complications including amputation can be reduced with MVPA, aerobic, and dynamic resistance exercise—independent of weight status.
- PA prevents weight gain and helps maintain healthy body weight in both adults and children and is strongest for those who spend >150 min/week in moderate-intensity activity.
- PA improves cognitive function across the lifespan, quality of life, symptoms of anxiety and depression, and sleep.

Source: *DiPietro L, Buchner DM, Marquez DX, Pate RR, Pescatello LS, Whitt-Glover MC. New scientific basis for the 2018 U.S. Physical Activity Guidelines. J Sport Health Sci. 2019;8:197-200.*

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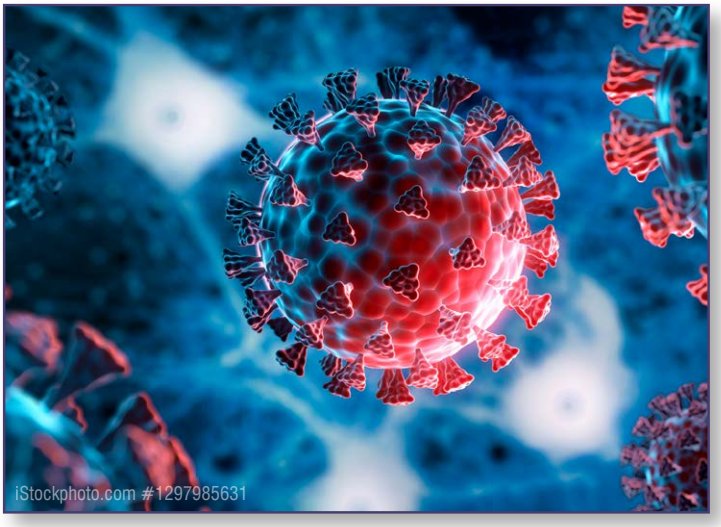
COVID-19 IMPACT ON LIFESTYLE BEHAVIORS OF PEOPLE WITH DISABILITIES



Using a web-based global survey, an international team of researchers found that COVID-19 had an outsized impact on healthy behaviors in people with disabilities, compared with people without disabilities. The overall impact of COVID-19 pandemic among the 2689 responses with full data available for analysis was reported as:

- >90% of people wore masks in public and were required to maintain social distancing
- 53% experienced lockdown or "shelter in place"
- 35% lost their jobs and/or lost source of income.

These metrics varied drastically country to country, but these experiences are known to have risen during the pandemic globally.

The research team found that people with disabilities were more likely to report worsening physical and mental health and dietary habits when compared with pre-pandemic levels (Table). Furthermore, perceived effects on physical health had significant impact on the reported degree of disability. (ler)

Table. Perceived physical and mental health, eating habit, body weight, and smoking pattern changes in people with and without disabilities during the pandemic

		Not Disabled, % (*n*)	Mild-Moderate, % (*n*)	Severe, % (*n*)	*P*
Physical health (physical fitness)	Better than	18.78 (246)[a,b]	17.18 (118)[a,c]	15.90 (110)[b,c]	
	Same as	41.68 (546)[a,b]	34.79 (239)[a,c]	28.18 (195)[b,c]	
	Worse than	39.54 (518)[a,b]	48.03 (330)[a,c]	55.92 (387)[b,c]	<0.001
Mental health (emotional wellness)	Better than	7.02 (92)[a,b]	6.70 (46)[a]	6.36 (44)[b]	
	Same as	31.60 (414)[a,b]	23.73 (163)[a]	19.08 (132)[b]	
	Worse than	61.37 (804)[a,b]	69.58 (478)[a]	74.57 (516)[b]	<0.001
Eating habits	Better than	30.61 (401)[a,b]	33.92 (233)[a]	29.19 (202)[b]	
	Same as	42.21 (553)[a,b]	34.93 (240)[a]	32.51 (225)[b]	
	Worse than	27.18 (356)[a,b]	31.15 (214)[a]	38.29 (265)[b]	<0.001
Weight gain	No	53.13 (696)[a]	45.71 (314)[a]	47.25 (327)	
	Yes	42.90 (562)[a]	48.33 (332)[a]	48.55 (336)	
	I don't know	3.97 (52)[a]	5.97 (41)[a]	4.19 (29)	0.005
Smoking patterns	Less than	5.27 (69)[b]	5.39 (37)	6.07 (42)[b]	
	More than	3.44 (45)[b]	4.80 (33)	6.65 (46)[b]	
	Same as	91.30 (1196)[b]	89.81 (617)	87.28 (604)[b]	0.021

[a] $P < 0.017$ was deemed to have significant differences between not disabled vs. mild-moderate groups with post-hoc analysis.
[b] $P < 0.017$ was deemed to have significant differences between not disabled vs. severe groups with post-hoc analysis.
[c] $P < 0.017$ was deemed to have significant differences between mild-moderate vs. severe groups with post-hoc analysis.
Mild-moderate, mild-moderate disability; severe, severe disability.

Source: Tuakli-Wosornu YA, Wang K, Fourtassi M, et al. Impact of the COVID-19 pandemic on the perceived physical and mental health and healthy lifestyle behaviors of people with disabilities. *Am J Phys Med Rehabil*. 2023 Feb 1;102(2):144-150. doi: 10.1097/PHM.0000000000002056.

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SEGMENTAL MENISCAL REPLACEMENT

Meniscal damage results in higher peak stress on the articular cartilage and leads to cartilage degeneration and osteoarthritis. Thus, in recent years there has been an increasing tendency to "save the meniscus" and to repair meniscal defects. However, this is not always possible and restoring meniscal function using scaffolds fulfills this gap. This approach requires the physical presence of an artificial meniscus to allow successful migration and colonization with precursor cells and vessels that lead to the development of organized meniscal tissue. Two meniscal scaffolds are currently available; 1 composed of aliphatic polyurethane named Actifit (Orteq Sports Medicine, Ltd.), and one based on collagen type I fibers called Collagen Meniscus Implant (Stryker Kalamazoo). Both provide an effective and safe solution to treat symptomatic patients with segmental meniscus mid-substance defects. Indeed, recent studies have demonstrated their ability to significantly improve patient satisfaction and clinical evaluation in the mid- to long-term. As such, these approaches hold great promise as a meniscus preservation option to facilitate long-term knee health. ler

Source: *Kyriakidis T, Pitsilos C, Verdonk R, Verdonk P. Segmental meniscal replacement. J Cartilage Joint Preserv. Published online: January 06, 2023. doi.org/10.1016/j.jcjp.2023.100100.*

EARLY SPORT SPECIALIZATION TRENDS & INJURIES IN JAPAN

Determining the effects of early specialization in a specific sport is difficult. Therefore, it is necessary to investigate its effects based on the type of sports. The purpose of this study was to investigate the proportion of participants who had been participating in a single sport, in individual or team sports from an early age and to compare the prevalence of acute and overuse injuries among these participants.

Methods: A total of 1377 adult participants (team sports = 700, individual sports = 637) retrospectively completed a questionnaire assessing sports participation from elementary school to high school and injury history (acute and overuse) at high school age. The proportions of the specialized / nonspecialized groups per sport type were compared, and differences in acute or overuse injury prevalence were examined.

Results: The proportion of the specialized group participants who continued to play the same single sport from elementary school age to high school age was greater in team sports (33.6%) than that in individual sports (19.2%) ($P < 0.01$). The specialized group participating in team sports had a greater prevalence of overuse injury at high school age than the nonspecialized group ($P < 0.05$) who previously participated in several sports. However, the prevalence of overuse injury at high school did not significantly differ between the specialized and nonspecialized groups participating in individual sports.

Conclusion: More children who continued to play only one sport from elementary school age to high school age played in team sports in Japan. They also had a higher prevalence of overuse injuries when they were at high school age. It is necessary to consider the environment to play multi sports before high school age, especially in team sports. ler

Source: *Nagano Y, Oyama T. Early sport specialization trends and injuries in former high school athletes specialized in sports. Open Access J Sports Med. 2023;14:1-7. doi: 10.2147/OAJSM.S385554.*

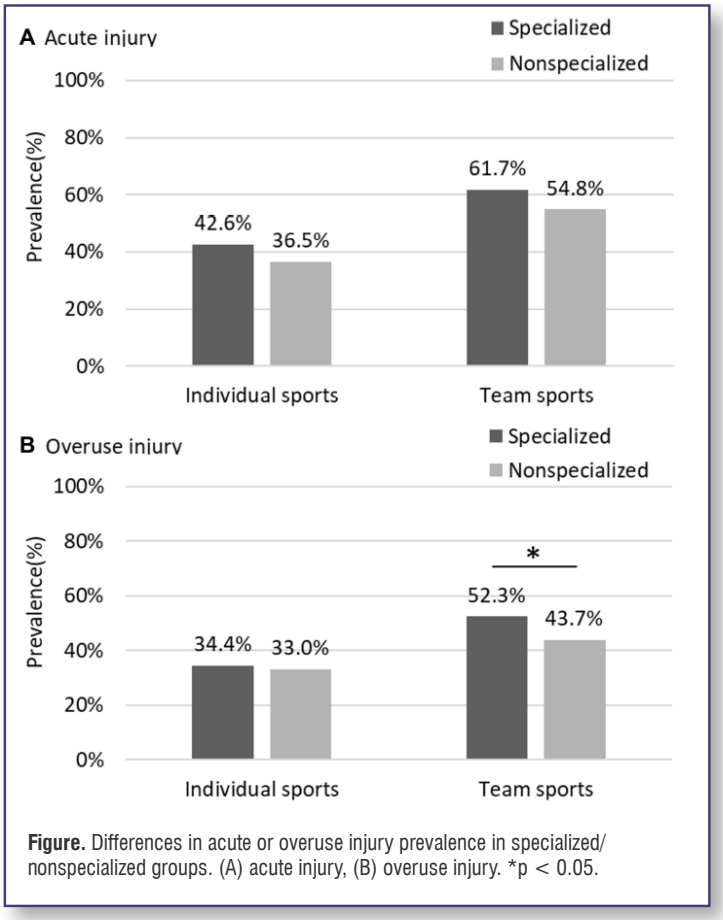

Figure. Differences in acute or overuse injury prevalence in specialized/nonspecialized groups. (A) acute injury, (B) overuse injury. *p < 0.05.

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SCHOOL PARK TEMPERATURES IMPACT CHILDREN'S PHYSICAL ACTIVITY TIME

Extreme heat may discourage physical activity of children while shade may provide thermal comfort. The authors determined the associations between ambient temperature, shade, and moderate to vigorous physical activity (MVPA) of children during school recess.

Methods: Children aged 8–10 (n = 213) wore accelerometers and global positioning system monitors during recess at 3 school parks in Austin, Texas (September–November 2019). Weather data originated from 10 sensors per park. The authors calculated shade from imagery using a geographic information system (GIS) and time-matched physical activity, location, temperature, and shade data. The authors specified piecewise multilevel regression to assess relations between average temperature and percentage of recess time in MVPA and shade.

Results: Temperature ranged 11°C to 35°C. Each 1°C higher temperature was associated with a 0.7 percentage point lower time spent in MVPA, until 33°C (91°F) when the association changed to a 1.5 lower time ($P <$ .01). Each 1°C higher temperature was associated with a 0.3 percentage point higher time spent under shade, until 33°C when the association changed to a 3.4 higher time ($P <$ .001). At 33°C or above, the direct association between shade and MVPA weakened ($P <$ .05), with no interaction effect above 33°C ($P >$ .05). Children at the park with the most tree canopy spent 6.0 percentage points more time in MVPA ($P <$ .01).

Conclusions: Children engage in less MVPA and seek shade during extreme heat and engage in more MVPA in green schoolyards. With climate change, schools should consider interventions (eg, organizing shaded play, tree planting) to promote heat safe MVPA. (ler)

Source: *Lanza K, Alcazar M, Durand CP, Salvo D, Villa U, Kohl HW III. (2023). Heat-Resilient Schoolyards: Relations Between Temperature, Shade, and Physical Activity of Children During Recess. J Phys Act Health. 2023;20(2):134-141. doi.org/10.1123/jpah.2022-0405.*

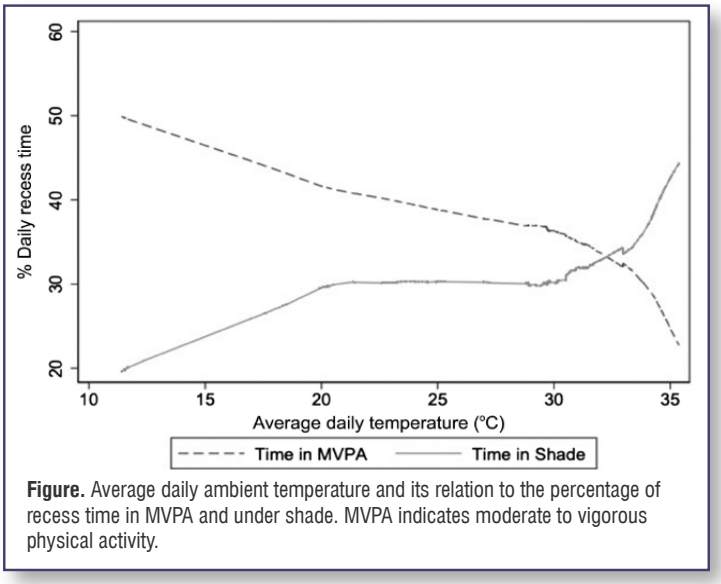

Figure. Average daily ambient temperature and its relation to the percentage of recess time in MVPA and under shade. MVPA indicates moderate to vigorous physical activity.

SYNOVIAL FLUID DYSREGULATION POST ACL RECONSTRUCTION

Patients with anterior cruciate ligament injury are at high risk of post-traumatic osteoarthritis and their response to reconstructive surgery and rehabilitation varies. Proteins identified in the orchestration of the acute inflammatory response may be predictive of patient outcomes. These authors used an unbiased, bottom-up proteomics approach to discover novel targets for therapeutics in relation to dysregulation in the orchestration of inflammatory pathways implicated in persistent joint inflammation subsequent to joint trauma.

The researchers aspirated synovial fluid from patients at 1 week and 4 weeks after anterior cruciate ligament reconstruction (ACLR). Interleukin 6 (IL-6) concentrations were quantified by enzyme-linked immunosorbent assay. Patients were segregated into IL-6low and IL-6high groups based on IL-6 concentrations in synovial fluid at 4-weeks post-operation and proteins in synovial fluid were analyzed using qualitative, bottom-up proteomics. Abundance ratios were calculated for IL-6high and IL-6low groups as 4 weeks post-operation:1 week post-operation.

A total of 291 proteins were detected in synovial fluid, 34 of which were significantly ($P <$ .05) differentially regulated between groups. Proteins associated with the classical and alternative complement cascade pathways were increased in the IL-6high compared to IL-6low group. Insulin-like growth factor-binding protein 6 (IGFBP-6) was increased by nearly 60-fold in the IL-6low group.

The research team found that patients segregated by IL-6 concentration in synovial fluid at 4 weeks post-ACLR demonstrated differential regulation of multiple pathways, providing opportunities to investigate novel targets, such as IGFBP-6, and to take advantage of therapeutics already approved for clinical use in other diseases that target inflammatory pathways, including the complement system. (ler)

Source: *Keller LE, Fortier LA, Lattermann C, et al. Complement system dysregulation in synovial fluid from patients with persistent inflammation following anterior cruciate ligament reconstruction surgery, J Cart Joint Preserv. Published online: January 06, 2023. doi.org/10.1016/j.jcjp.2023.100114.*

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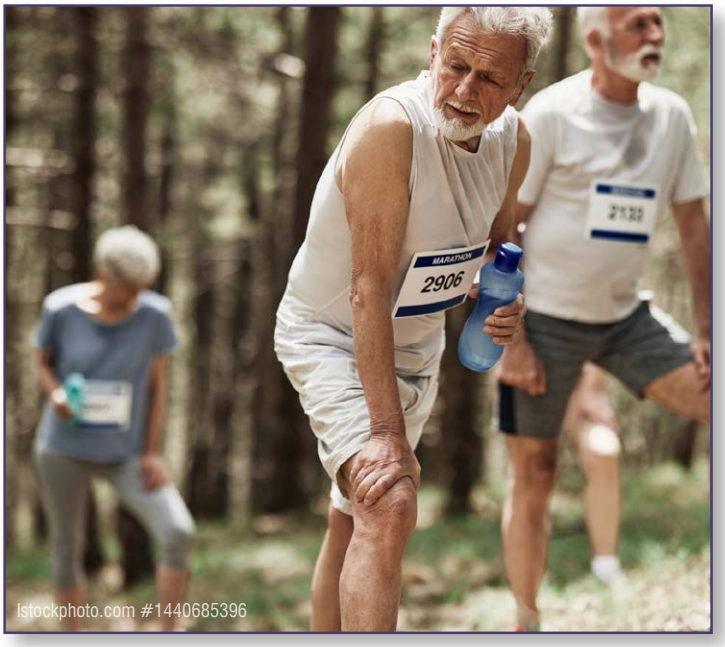

Chicago Marathon® participants helped orthopedic researchers further understand the impact of long-distance running on bone and joint health, specifically knee and hip arthritis in recreational runners. Results from the largest survey of marathon runners ever conducted showed no association between cumulative running history and the risk for arthritis.

"Despite growing knowledge that running and being active can be healthy for your joints, there is a continued dogma among the healthcare community that patients should stop running to avoid wearing out their cartilage," said lead author Matthew J. Hartwell, MD, an orthopedic surgery sports medicine fellow at University of California San Francisco. "In fact, our survey showed that 1 in 4 people have received a recommendation by their physician to reduce their running volume, and for those with arthritis, nearly 50% of runners were told by their physicians to stop running altogether."

Hartwell and colleagues conducted the prospective cohort study, "Does Running Increase the Risk for Hip and Knee Arthritis? A Survey of 3,804 Chicago Marathon Runners," during his residency at Northwestern University Feinberg School of Medicine in Chicago. It was presented at the 2023 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS).

The electronic survey was completed by 3,804 participants registered for the 2019 and 2021 Chicago Marathons (mean age, 43.9 years). Participants had run an average of 5 or fewer marathons, and they had been running for an average of 14.7 years.

The survey featured 30 questions targeted at assessing:

- Demographic information (age, sex, height, weight, country of origin and occupation)
- Running history (number of years running; average weekly mileage over past year; average running pace during training runs; number of marathons completed, including ultra-marathons; and any cross training)
- Hip/knee health (occurrence of hip or knee pain over past year that prevented running; history of hip or knee injuries that required a break in running; family history of hip and/or knee arthritis; surgical procedures on hip or knee; and receiving hip or knee arthritis diagnosis)

These data showed prevalence of hip and/or knee arthritis was 7.3%. Prior hip/knee injuries or surgery, advancing age, family history, and BMI were risk factors for arthritis. Cumulative number of years running, number of marathons completed, weekly mileage and mean running pace proved not to be significant risk factors for arthritis.

"Our multivariate analysis showed that the factors that increase a

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person's risk for arthritis are the same for anyone with joint degeneration—whether or not they're a runner. Those factors include increase in age, BMI, a family history of hip or knee arthritis, and whether they've had injuries or knee surgery," said Hartwell.

Participants were also asked if a doctor had ever advised them to stop or reduce their running, if they were still running at the time of questionnaire completion, and if they plan to run another marathon. The majority (94.2%) of runners planned to run another marathon despite 24.2% of all participants being told by a physician to do otherwise.

"Recreational runners are a dedicated group of people who use the sport for exercise, mental clarity, or to challenge themselves," said Vehniah K. Tjong, MD, FAAOS, associate professor of orthopedic surgery at Northwestern University. "Our hope is these findings educate physicians, so they don't instinctively advise against running and they work to meet patients on their level—because, as these data show, runners are likely to continue running despite medical advice."

OUTPATIENT TJAS GET HIGH RANKINGS IN PATIENT SATISFACTION & OUTCOMES SURVEY

HOOS JR Questions for THA patients	None	Mild	Moderate	Severe	Extreme
Hip pain when going up or down stairs	28	5	0	0	0
Hip pain when walking on uneven surface	29	4	0	0	0
Difficulty rising from sitting	29	4	0	0	0
Difficulty bending to floor/pick up an object	29	4	0	0	0
Difficulty lying in bed (turning over, maintaining hip position)	28	5	0	0	0
Difficulty sitting	31	2	0	0	0
KOOS JR Questions for TKA patients	None	Mild	Moderate	Severe	Extreme
Knee stiffness when waking up in the morning	8	6	2	0	0
Pain when twisting/pivoting on your knee	13	2	1	0	0
Pain when straightening knee fully	15	0	1	0	0
Pain when going up or down stairs	11	3	1	1	0
Pain when standing upright	14	1	1	0	0
Difficulty rising from sitting	15	1	0	0	0
Difficulty bending to floor/pick up an object	16	0	0	0	0
KOOS JR Questions for UKA patients	None	Mild	Moderate	Severe	Extreme
Knee stiffness when waking up in the morning	20	13	6	3	0
Pain when twisting/pivoting on your knee	33	5	1	2	1
Pain when straightening knee fully	36	4	1	1	0
Pain when going up or down stairs	28	7	3	3	1
Pain when standing upright	36	3	1	1	0
Difficulty rising from sitting	32	5	2	2	0
Difficulty bending to floor/pick up an object	32	6	0	3	0

Table 1. HOOS JR and KOOS JR survey responses.

In the first study to establish patient satisfaction after outpatient joint arthroplasty (TJA) in an academic medical center (AMC) setting, patients indicated they were very likely to undergo the outpatient procedure again and had high patient reported outcomes (PROs). The study, "Patient Satisfaction and Outcomes following Outpatient Joint Arthroplasty in Academic Medical Centers," presented at the 2023 AAOS Annual Meeting, also showed that patients had short discharge times and low readmission rates after outpatient total joint arthroplasty.

TJA, which includes total knee arthroplasty (TKA) and total hip arthroplasty (THA), is one of the most common surgeries in the United States, with almost 1.25 million hip and knee arthroplasty procedures performed in 2019 alone. Unicondylar knee arthroplasty (UKA), also known as partial knee arthroplasty, is also on the rise as it is less invasive than other procedures. TJA and UKA procedures are increasingly being done on an outpatient basis, with some predictions showing that more than half of all TJA procedures will be outpatient by 2026. While previous studies reported on patient satisfaction in ambulatory surgery centers (ASCs), there weren't any studies that evaluated patient satisfaction and outcomes for outpatient TJAs and UKAs at AMCs.

"Academic medical centers historically haven't done TJAs on a same-day basis," said lead author Soham Ghoshal, medical student, Harvard Medical School, Boston. "The literature has shown that one of the biggest factors influencing patient satisfaction and whether they would undergo these procedures at AMCs is the length of stay. This is important because a longer length of stay is often associated with a higher risk of medical errors, complications, and lower recovery metrics. Inpatient procedures are more expensive as well. If we can show that patients want these procedures on an outpatient basis, that it is safe, and outcomes are similar, we can help guide AMCs to shift TJAs and UKAs to outpatient."

The researchers conducted a prospective cohort study in patients who underwent TJA or UKA at 2 large AMCs from May 1, 2018, to Dec. 31, 2021. Patients were surveyed on whether they would repeat the surgery, their experience with same-day discharge, and reasons for readmission or reoperation. Hip Disability and Osteoarthritis Outcome Score, Joint Replacement (HOOS JR) survey and Knee Disability and Osteoarthritis Outcome Score, Joint Replacement (KOOS JR) were used to measure PROs. PROs included pain, stiffness, and difficulty when performing hip or knee movements.

The study included a total of 281 TJA and UKA procedures performed on an outpatient basis at AMCs, with 66 THA, 35 TKA and 180 UKA patients. The study reported:

- Cumulatively, 94.6% of patients would undergo their procedure again, with 100% of THA, 93.8% of TKA and 93.3% of UKA patients saying they would redo the surgery.
- Of all patients, 92.7% would choose to be discharged the same day again, with 94.3% of THA, 81.3% of TKA and 95.6% of UKA

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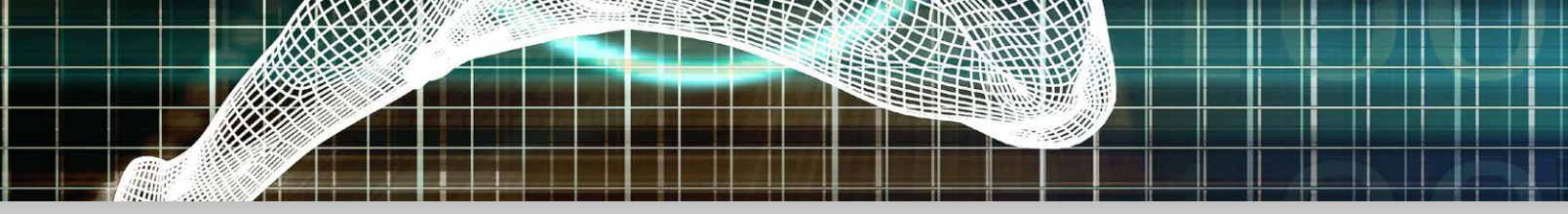

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patients stating that if they needed the surgery again, they would have their surgery on an outpatient basis.

- Mean time to discharge was 5.4 hours for THA, 4.9 hours for TKA, and 4.7 hours for UKA.
- Regarding PROs, THA patients reported a mean HOOS JR score of 95.6; TKA patients reported a mean KOOS JR score of 89.8; and UKA patients reported a mean KOOS JR score of 86.3.
- A total of nine patients were readmitted, with readmission rates of 3.0% for THA, 2.9% for TKA and 5.6% for UKA. There were no repeated readmissions.

"Overwhelmingly, joint arthroplasty patients would have the procedure done as outpatient if they had to again," said Vivek M. Shah, MD, FAAOS, director of outpatient arthroplasty, Department of Orthopedics, Brigham and Women's Hospital, Boston, and member of the faculty, Harvard Medical School. "Our study showed that there are many benefits for the patient and healthcare system to patients being discharged that same day as the procedure at an AMC. AMCs have the advantage that should a patient need to be admitted for further observation, that transition can easily be done." ler

THA PATIENTS UNDER 65 HAVE LOW REVISION RATES AT 8 YEARS

	THA (N=5,124)			
Factors	Odds Ratio	Lower Limit	Upper Limit	p-value
Preop VR-12 PCS	0.999	0.969	1.031	0.966
Age	1.004	0.968	1.041	0.838
Sex: Female vs. Male	1.078	0.624	1.862	0.788
Race: Black vs. White	2.76	1.148	6.633	0.023
Race: Other vs. White	0.55	0.169	1.786	0.32
Charlson Comorbidity Index	0.854	0.508	1.436	0.552

Table. Association between Independent Factors and Linked Revisions among patients age 18-65 years.

With an increase in total hip arthroplasty (THA) procedures being performed on younger patients, these patients have historically had poor long-term outcomes associated with implant failure. However, a recent study presented at the 2023 AAOS Annual Meeting, which utilized data from the American Joint Replacement Registry (AJRR), found that only 1% of sampled patients needed revision surgery for THA within an 8-year period. The study also found higher THA revision rates among Black patients when compared to white patients.

"The demand for total hip replacements is expected to increase 174% from 2005 to 2030, and 28% of the 572,000 THA procedures performed annually are in patients under the age of 55," said lead author David Cieremans, MS, a medical student at Philadelphia College of Osteopathic Medicine. "When a young and active patient is exploring THA, it's important for their surgeon to understand the expected life span of the implant to help make informed decisions. The AJRR provided an incredible resource for our team to obtain robust data on hip replacements, along with a standardized metric to analyze surgical trends and patient outcomes from around the country."

Younger THA patients are more active and have experienced an increase in implant failure, most commonly due to component loosening, polyethylene wear, instability, and infection. However, as surgical techniques and implant designs have improved over the past 15 years, the researchers sought to determine if the same could be said for outcomes and implant longevity.

In the study, "Trends in Complications and Outcomes in Patients Aged 65 and Younger Undergoing Total Hip Arthroplasty: Data from the American Joint Replacement Registry," the team used the Registry's database to identify all THA procedures performed from 2012 through 2020 in patients aged 18 to 65. Exclusion criteria included patients with revision and oncologic THA cases, conversion from prior surgery and non-elective cases. The study measured primary outcomes including cumulative revision rate, 90-day readmission rate, and reason for revision. In total, 5,153 patients were included in the analysis (51% female; average age 56.7 ± 7.8 years). Mean follow up was 39.57 months.

Results of the study included:

- Fifty-three patients (1%) underwent revision during the study period; 74 patients (1.4%) were readmitted within 90 days.
- Most common causes for revision were infection (20.8%), instability (15.1%), periprosthetic fracture (13.2%), and aseptic loosening (9.4%).
- Most common reasons for 90-day readmission without revision were infection (22.9%), pain (9.5%) and periprosthetic fracture (5.4%).

Racial disparities in revision rates were evident, as readmission within 90 days requiring revision were 2.76 times more common in Black patients compared to white patients.

"This is an important finding, and more long-term outcome studies are needed to understand why Black patients are being disproportionately affected," said senior author Ran Schwarzkopf, MD, MSc, FAAOS, professor of orthopedics at NYU Langone Orthopedic Hospital. "Other research has concluded that Black patients are 30% less likely to undergo an elective total hip replacement than white patients, and patients from

lower socioeconomic backgrounds experience higher baseline scores for pain and function. Given the advances in THA and favorable outcomes for patients under the age of 65, the orthopedic community needs to work to improve patient outcomes for all patients."

While the results of this study represent trends in data and cannot yet be used to make definitive conclusions on outcomes due to inherent limitations of the database, Schwarzkopf noted that the team looks forward to continuing to follow the patient cohort over a longer period of time. ler

TJA CASELOADS NEED TO DOUBLE TO MEET DEMAND BY 2050

A new study presented at the 2023 AAOS Annual Meeting found that, based on projection models, orthopedic surgeons will need to either double their total joint arthroplasty (TJA) caseload or increase the number of surgeons by 10% every 5 years to meet demand.

In 2019, approximately 1.25 million TJA procedures, including hip and knee arthroplasties, were performed. One of the most common surgeries in the United States, the growing demand for TJAs has outpaced the size of the orthopedic workforce. As orthopedic surgeons report high rates of burnout, there is concern that the workforce may not be able to keep up with the growing demand for TJAs.

The population-based study utilized national data from the National Inpatient Sample (NIS) and Association of American Medical Colleges (AAMC) to determine the number of TJAs and active orthopedic surgeons from 2010– 2020. To determine growth trends, the researchers used arthroplasty-to-surgeon ratios (ASRs) and an arthroplasty surgeon growth indicator (ASGI). The ASR values estimate the average annual output of total hip arthroplasty (THA), total knee arthroplasty (TKA) or TJA procedures performed by an orthopedic surgeon in a given year. ASGI values were calculated using the 2017 ASR values as the standard point of comparison.

Survey Findings

- The annual volume of primary TJAs will grow 70% to 2,257,326.
- A higher growth in demand for THAs compared to TKAs was observed (1,219,852 THAs vs. 1,037,474 TKAs by 2050).
- Number of active orthopedic surgeons is projected to decrease 14% by 2050, from 18,834 surgeons in 2020 to 16,189 in 2050. The number of residents (post-graduate year one) is projected to grow 39% by 2050 from 844 residents in 2020 to 1,173 in 2050 and joint reconstruction fellowship positions are forecasted to grow by 149% from 189 fellows in 2020 to 460 in 2050; however, even this workforce would be unable to keep pace with the growing number of TJA procedures.
- In 2017, the average primary TJA caseload per active orthopedic surgeon was 65.2 procedures while the projected TJA-ASRs for 2050 is 139.4. The number of TJAs performed per surgeon will double by 2050 to meet the projected demand.
- Increasing the number of orthopedic surgeons by 10% every 5 years could ensure the caseload per surgeon remains similar to the 2010–2017 numbers. ler

OLDER PATIENTS EXHIBIT BETTER PAIN RELIEF, QOL AFTER TKA

Patients aged 55 and younger were found to have worse pain, function, and quality of life (QOL) following total knee arthroplasty (TKA) compared to patients 75 years and older, according to a study presented at the 2023 AAOS Annual Meeting that looked at age-related differences in patient outcomes following TKA.

TKAs are one of the most performed surgical procedures in the United States, with the number of procedures expected to reach 7.4 million by 2030. While mean age for patients undergoing TKA is 67.2 years, a growing number of younger and more active patients are undergoing TKA.

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"There was controversy in the existing literature examining knee replacement outcomes by age as some studies concluded young patients do better, other studies showed they do worse and then there were studies saying there was no difference based on age," said lead author David Ayers, MD, FAAOS, orthopedic surgeon, University of Massachusetts Chan Medical School. "These studies included relatively small sample sizes and different types of methodologies, so we wanted to improve upon our base knowledge by analyzing a large data sample."

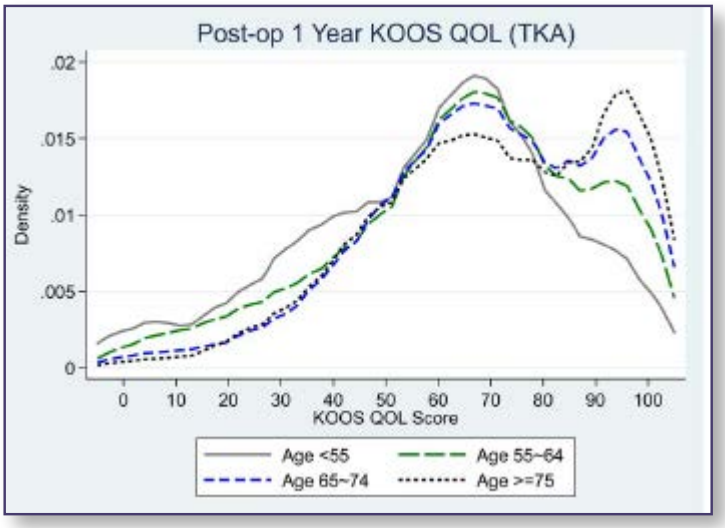
The team used data from the Function and Outcomes Research for Comparative Effectiveness in Total Joint Replacement (FORCE-TJR) consortium, which is managed by Ayers at the University of Massachusetts Department of Orthopedics and Physical Rehabilitation. This consortium includes over 235 surgeons from hospitals across the country, providing a representative sample of national data.

The study, "Age-Related Differences in Pain, Function and Quality of Life Following Primary Total Knee Arthroplasty," analyzed 11,602 patients who underwent a unilateral (one knee) TKA. Patients were segmented into cohorts by age: less than 55, 55-64, 65-74, and 75 years and older. The team collected the following patient information prior to surgery and at one-year postoperative:

- Detailed list of demographic data
- Comorbidity conditions using the Charlson Comorbidity Index
- Patient reported outcome measures (PROMs), including Knee Injury and Osteoarthritis Outcomes Scores (KOOSs) to determine their levels of pain, function, and QOL
- A short-form health survey (SF-12) which provided a Physical Composite Score and Mental Composite Score to assess the overall physical, social and emotional status of the patient

The study found that prior to surgery, younger patients (aged 55 and younger) reported worse pain, function, and QOL compared to older patients, especially those 75 years and older. At 1 year after TKA, younger patients still reported slightly worse pain, function, and QOL, but better function scores than patients older than 75.

"There's a misnomer that patients under 55 who need a knee replacement are athletes or physically active individuals who have been exercising all their life but had a previous injury which caused osteoarthritis (OA)," said Ayers. "Instead, we found that overall, this group had



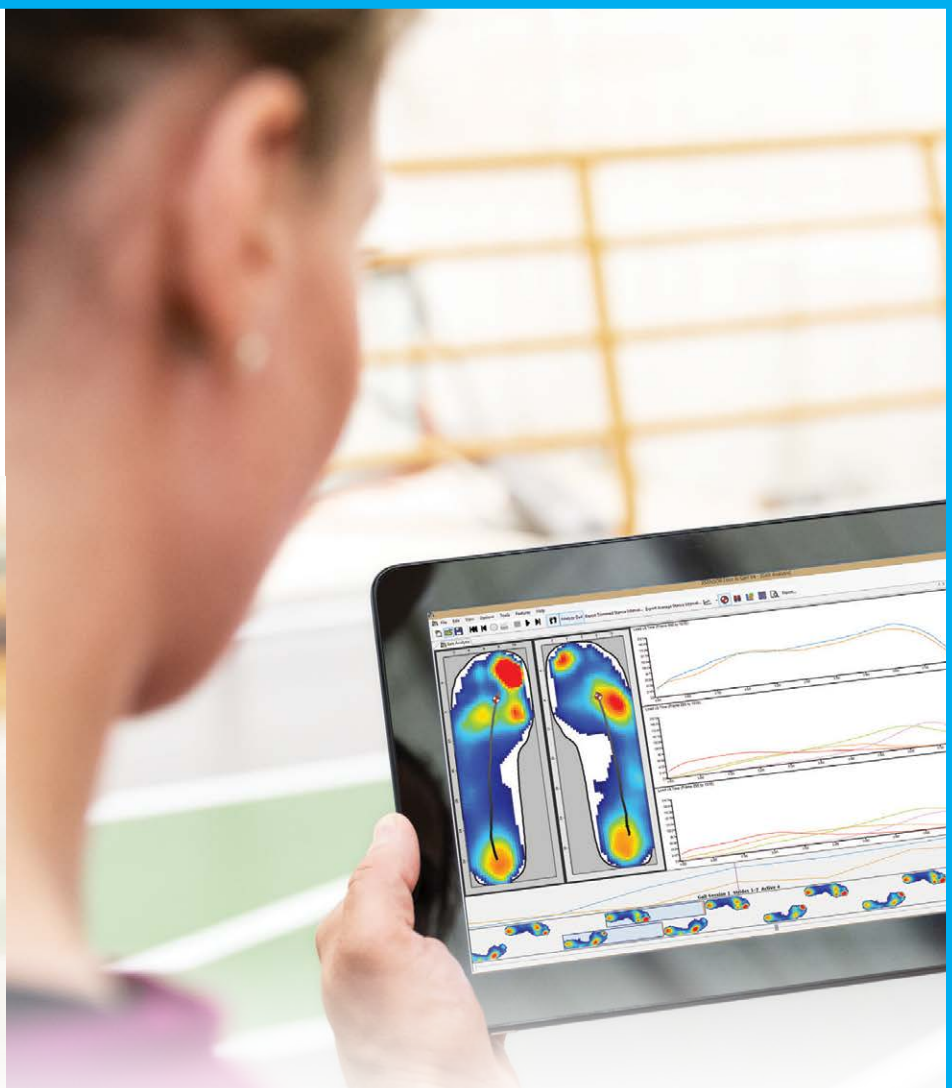
a higher incidence of obesity (BMI>35), medical comorbidities, and were more likely to be current smokers. These factors and any previous injuries to the knee can result in arthritis, which can be significant enough to lead to TKA."

Despite the difference in pain and QOL scores between the age groups, the study showed that all 4 groups benefited from the surgery greatly and experienced major improvements in pain, function, and QOL.

"Because of the successful nature of TKAs and with improved anesthetic techniques and rapid recovery protocols, age does not always correlate to being an optimal candidate for TKA, as it has more to do with a patient's medical fitness level," said Ayers. "If a patient is in good health, they can undergo the surgery. Based on our findings, orthopedic surgeons can recommend TKA as an appropriate and life-changing operation for people with advanced arthritis who do not respond to conservative care, even those over 75 years of age."

To further guide surgeons and patients through the decision-making process, the research team used a multivariate regression analysis and found that age was a predictive factor for a patient's postoperative pain score at 1 year. These data help them know what to expect in terms of pain at 1 year and set realistic expectations.

The team is currently testing a predictive algorithm that will provide patients an analysis of their expected pain, function, and QOL scores 1 year after surgery.



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Balance and Strength Exercises Can Help Reduce Falls in Older Adults

By Tim Wiedenmann, Steffen Held, Ludwig Rappelt, Martin Grauduszus, Sofie Spickermann, and Lars Donath

Fall prevention is of importance for maintaining independency of daily living, well-being, and quality of life in older adults and given demographic trends, an urgent economic challenge for the healthcare system.

Falls are a serious health concern and a major cause of morbidity and mortality in community-dwelling older adults. About 1 in 3 older adults above the age of 65 fall at least once a year and half of them are recurrent fallers. The prevention of falls is, therefore, not only of importance for maintaining independency of daily living, well-being, and quality of life in older adults but also an economic challenge for the healthcare system. Available clinical practice guidelines for fall prevention in the older population underpin the importance of physical activity and exercise. The majority of the included exercise-based fall prevention studies focus on balance exercises or resistance training. While tendencies favoring balance exercises for the prevention of falls can be observed, it is not entirely clear whether balance exercise alone or in a combination with multiple exercise forms is most effective for reducing fall risk.

Against this background, the aims of this network meta-analysis are: (i) to rank different physical activities based on their effect on fall prevention in older adults and (ii) to analyze which form of exercise is most suitable for fall prevention.

Methods

The studies included in this network meta-analysis were identified through a comprehensive search in 5 biomedical databases (PubMed, SportDiscus, CINAHL, Web of Science and EMBASE). The study authors included randomized controlled trials (RCTs) that compared the occurrence of fall events in older adults who received different interventional treatments.

The following inclusion criteria based on the PICOS approach [population (P), intervention (I), comparators (C), main outcome (O), and study design (S)] were applied: Full-text article published in English in a peer-reviewed journal; participants were community-dwelling, independently living people involved in studies with a mean age of at least 65 years and an age larger than 60 years when subtracting 1 standard deviation from the studies' mean age, without additional diseases (eg, stroke, chronic stroke, Parkinson's disease, multiple sclerosis, dementia, hip fractures or other fractures) or an acute or chronic mental or physical illness (such as cancer, depression, mild cognitive impairment, diabetes mellitus, or chronic obstructive pulmonary disease,) (P). All studies that included at least 1 exercise intervention group and 1 control or another exercise intervention group were eligible. Supplement and medication studies were excluded (I). Comparators were groups with no or light physical exercise (C).

This article has been excerpted from "Exercise Based Reduction of Falls in Community-dwelling Older Adults: A Network Meta-analysis" by the same authors, which was published in the *European Review of Aging and Physical Activity*. 2023;20(1):1. https://doi.org/10.1186/s11556-023-00311-w. Editing has occurred, including the renumbering of tables and figures, and references have been removed for brevity.

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Documentation of the incidence of falls, to estimate the risk ratio (RR), for at least 6 months, regardless of whether they were documented within the intervention period, as a follow-up after the intervention, or during the intervention and in a follow-up period. A fall was defined as a subject's unintentionally coming to rest on the ground or at some other lower level, not as a result of a major intrinsic event (eg, stroke or syncope) or overwhelming hazard (O). Furthermore, the studies had to be 2- or multiarmed randomized controlled trails (S). The exclusion criteria were: (1) No adequate control conditions, which made integration into the network impossible, and (2) the use of an alternative supporting structures or systems such as an exoskeleton.

To estimate the effect of exercise on the incidence of fallers, the number of fallers and non-fallers in each intervention group were extracted. For the simplification of the network, similar treatments haven been summarized in (i) Active Control (interventions that are not thought to influence the outcome of falls such as light stretching and relaxation); (ii) Combined Postural Control Training (resistance or endurance training performed additionally to postural control training); (iii) Endurance Training; (iv) Inactive Control; (v) Multifactorial Training (forms of training that included other non-exercise related factors influencing the risk of falls (such as home hazard management and visual, educational or behavioral interventions) in addition to postural control training); (vi) Postural Control Training (balance, coordination and/or multitask training); and (vii) Resistance Training.

The RR was calculated for all interventional treatments by dividing the incidence of the intervention group by the incidence of the reference group or by using RR values if they were provided. Additionally mean error and 95% confidence interval (95%-CI) were evaluated. The estimations of treatment effects were calculated based on a random effects model; the Inactive Control served as the reference treatment. A ranking was created based on the P-score of the individual treatments. A forest plot was created to further visualize the ranking and effects of the treatments. The decomposed Q-statistics (within and between designs) were used to interpret potential heterogeneity and inconsistency. Heterogeneity was further quantified by I2. Funnel plots were created to check potential publication bias.

Results

Seventy-six comparisons from 66 RCTs with 4,420 (61% male) participants aged 77 ± 4 (68–88) years were included in this network meta-analysis. The network model revealed low heterogeneity (I2 = 28.0, 95%CI 1.0 to 47.7%) and inconsistency (Q between designs = 15.1, $P = 0.37$). Postural control training was found to be most effective in preventing falls (Postural Control Training (home): RR = 0.66, 95%-CI [0.49; 0.88], P-score = 0.97; Postural Control Training: RR = 0.82, 95%-CI [0.75; 0.91], P-score = 0.82). Combined and multifactorial interventions also display a robust but smaller effect (RR = 0.88–0.93, P-score = 0.65–0.47). The ranking of the different treatments is depicted in Figure 1.

These reductions in fall risk are also present when postural control training is performed at home and largely unsupervised.

Discussion

The key finding was that balance and strength focused exercise modes are the most beneficial for the prevention of fall events.

Among all included exercise modes, balance-type exercises revealed the lowest relative risk for a fall event and thus received the highest P-score, outranking the resistance training and resistance training combined approaches. These findings are aligned with previous findings and reflect the majority of available clinical guidelines but surpass them. This network meta-analysis displays that these reductions in fall risk are also present when postural control training is performed at home and largely unsupervised.

Multifactorial Training, Combined Postural Training (home), and Combined Postural Training are associated with a slight reduction of fall risk and a high precision of data, indicated by narrow confidence limits. These findings suggest that an interventional approach with multiple different exercise modes or other non-exercise related factors are inferior in magnitude but robust in effect occurrence of fall risk reductions compared with the most beneficial postural control training interventions when they are performed isolated. This is at least partially in line with a 2007 meta-regression and meta-analysis in which Campbell et al found that single factorial interventions had similar but slightly favorable effects compared to multifactorial interventions when it comes to the prevention of falls. Although the effects of the combined interventions are inferior to the best single factorial interventions, the high precision of the data combined with the large amount of included evidence (51 direct comparisons) leads to the assumption that some combined and multifactorial interventions might be a valuable alternative. The value of multifactorial interventions might even be higher when the interventions are designed with different domains that are specific to the needs of the individual patient.

In contrast, Resistance Training, Resistance Training (home), Endurance Training, and Multifactorial Training (home) do not have a robust positive effect on the relative risk of falls. While these interventions display a RR that is also slightly lower than the control, they indicate

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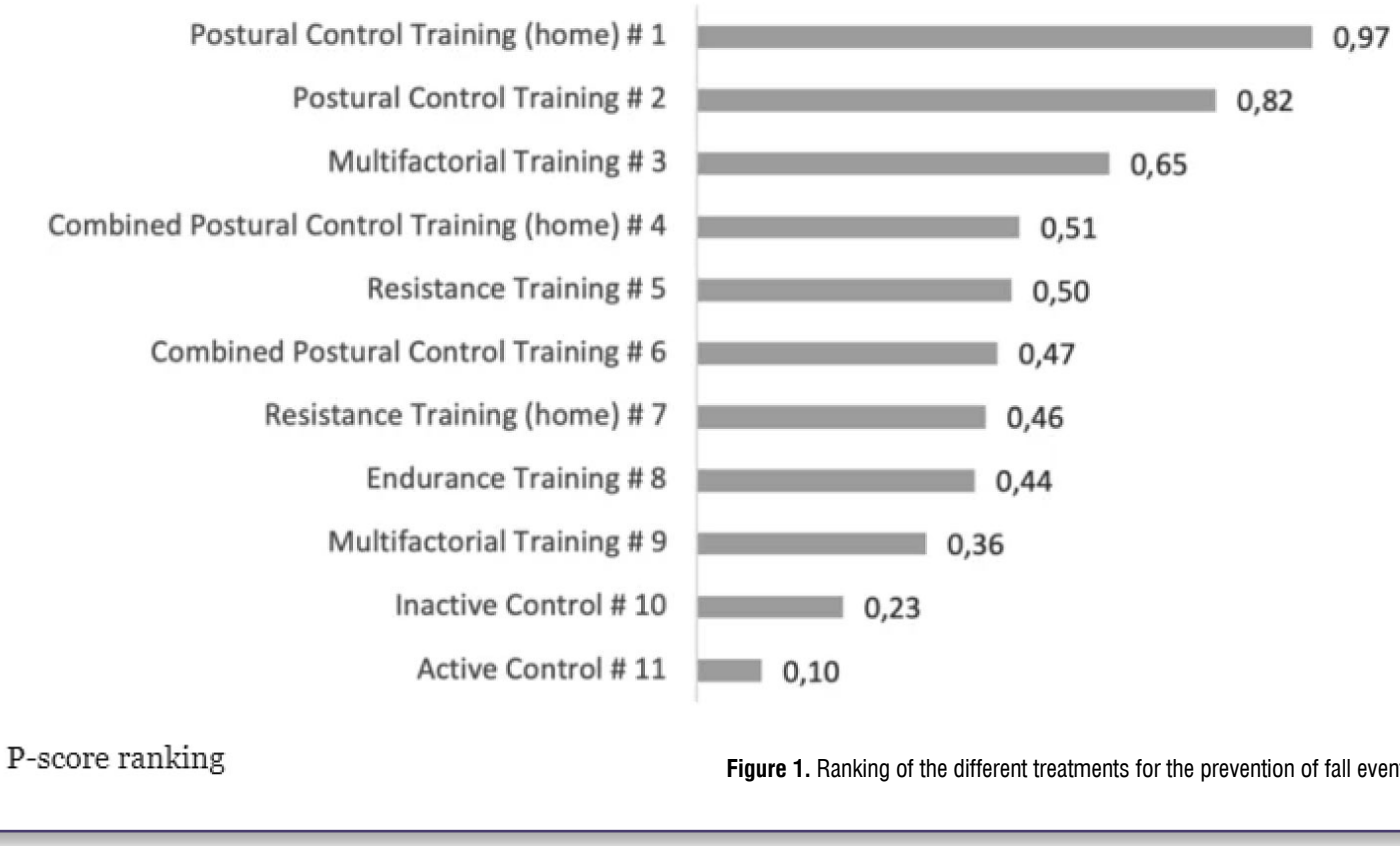

Figure 1. Ranking of the different treatments for the prevention of fall events.

large confidence limits. There is a noticeable difference in the risk reduction between Multifactorial Training, which places third in the treatment ranking, and Multifactorial Training (home), which has no clear positive effect on the reduction of fall risk. A similar difference but considerably smaller in magnitude is observed for Resistance Training and Resistance Training (home). These observations are in line with other meta-analyses. A possible explanation for these shared findings might be that the compliance, adherence, and the effort exerted in training are not sufficient when an intervention is performed largely or completely unsupervised at home.

The 2 interventions that fall out of line are the Postural Control Training and the Combined Postural Control Training. For these 2 approaches the unsupervised home training displays a larger effect than the supervised intervention or the same effect for postural control training and the combined intervention respectively. However, there are only 2 studies directly comparing Postural Control Training (home) with other interventions included in this analysis, and therefore, the findings should be interpreted with caution.

Conclusion

The evidence summarized in this network meta-analysis shows that balance training is the mode of physical activity or exercise that has the strongest positive impact on fall risk. For interventions that combine different modes of exercise or other non-exercise interventions the influence becomes less strong (up to about 12% reduction of fall risk) but still rather clear due to narrow confidence limits. With the exception of balance training–type exercise and the combined postural training approach, training performed at home was not as effective as training that was completely supervised. Future studies should investigate the role of training intensity and effort as well as the effects of multimodal exercise training over longer study periods up to ≥ 1 year. ler

There is a noticeable difference in the risk reduction between Multifactorial Training, which places third in the treatment ranking, and Multifactorial Training (home), which has no clear positive effect on the reduction of fall risk.

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A Step Short: Why We Need More Research on Prefabricated Carbon Composite Ankle-Foot-Orthoses

By Lindi Mitsou, MSPO, CPO; Nicholas Carr, BS; Jordan Dunn, BS; Jayne Kernodle, BS; Yelizaveta Kozlov, BS; Jillian Picard-Busky, ATC, LAT; Abigail Riley, BS; and Alex Wright, BS, NREMT

As the population ages and the twin epidemics of diabetes and obesity compromise mobility in ever-more patients, clinicians will need to understand the design specifics of these devices. But what do we know and is it enough?

Many patients with gait abnormalities utilize lower limb orthoses to provide support, correction, and enhance function of the lower extremity. A variety of design options from joint level(s) to material selection are available and must be appropriately selected for individual patient treatment plans. A popular design choice for patients experiencing difficulties with clearance in swing and forward propulsion in terminal stance are prefabricated carbon fiber composite ankle foot orthoses (C-AFOs). Carbon fiber composites provide energy storage and return as well as high stiffness to weight ratios making them an ideal material for many patients. As a result, there are numerous prefabricated C-AFOs on the market, varying in design and stiffness. As this market continues to grow, it is important for clinicians to understand how these devices function as a group and differ from each other to appropriately select interventions for their patients.

Utilizing Gait Parameters and Joint Angles in Gait Research

The main goal of human gait is efficient locomotion, requiring four distinct functions: propulsion, shock absorption, stance stability, and conservation of energy.[1] Locomotion is achieved through the reciprocal pattern of gait as defined by Jacquelin Perry and subsequent researchers.[1,2] By determining and describing each period and phase of the gait cycle, Perry and others have codified normal human gait in such a way that allows clinicians and researchers to effectively analyze gait observationally and in lab settings.

Numerous biomechanical parameters can be utilized to examine gait and it is important that researchers select those that provide relevant information. In a 2017 systematic review, Roberts et al determined that temporospatial parameters are the most frequently collected parameter in research of human gait.[3] Temporal and spatial parameters refer to the kinematic information regarding time and distance, respectively. The most common temporal parameters include cadence and walking velocity.[3,4] Frequently investigated spatial gait parameters include step length, stride length, step width, and foot progression angle. In research of non-pathological human gait, the most cited spatial parameter is step or stride length.[3,4]

Temporospatial gait parameters provide clinicians and researchers with clear information regarding reciprocation, or lack thereof, between the lower limbs. Asymmetries in temporospatial parameters are often cited in pathologic gait as deviations and examining

Continued on page 35

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changes in these parameters is integral to patient treatment plans. When analyzing gait, clinicians assess gait parameters through observation, comparing them to healthy gait criteria as defined by Jacquelin Perry and others. A 1993 study by the US Department of Veterans Affairs collected temporospatial gait parameter data in healthy adults to provide as reference for future clinical and research application.[4] In their study, researchers defined several characteristics that influence cadence, velocity, and step length: environment, sex, and age. The environment was determined to be influential as walking velocity decreased with indoor, short walkways versus walking outdoors and on longer walkways. With regards to sex, female participants walked with shorter step lengths, at slower overall velocities, and had higher cadence values than their male counterparts. Finally, increasing age resulted in reduced gait velocity and step length with minimal changes in cadence. The same study also aimed to define normal values for step length, walking velocity, and cadence for numerous defined groups based on age, sex, and task (i.e., self-selected speed instructions: slow, normal, and fast). It is important to consider each of these variables when examining gait, both clinically and in lab settings.

Assessing joint angles has also been established in gait analysis.[2,5] Often presented as angle-angle diagrams, total joint excursion (range of motion), or joint angle versus time graphs,[5] joint angle kinematics provide valuable information regarding the overall movement of the body and its limbs during the gait cycle. The joints of the lower limb aid in the transmission of forces and loads during weight acceptance and in the maintenance of stability during mid-stance of gait.[1,6] In swing phase, proper joint angles are important for toe clearance and limb advancement.[1] It is necessary to consider all joints of the lower limb as positioning alters muscle force generation and segment loading. Hip and knee joint position can impact ankle range of motion and muscle force production at the ankle and vice versa.[6,7] Therefore, altering range of motion with orthotic intervention will impact the joint kinematics of not only the braced joint(s), but those of the entire limb.

Though clinicians and researchers can approximate joint angles with observational gait analysis, motion capture is the most reliable tool in analyzing body segment positioning and joint angles.[2,5] Researchers have established normal values for joint angles in each phase of gait via motion capture analysis systems (or electro-goniometry).[1,5,6] A year after the 1993 study, the US Department of Veterans Affairs released reference data for knee and hip joint angles examining the same variables as in the temporospatial parameters study. They determined that sex significantly affected knee excursion in all parameters measured with greater values for male participants. Though less consistent, sex may also affect hip flexion-extension and rotation. Minimal but significant changes were noted with increase in age resulting in a reduction of knee flexion in mid-stance by 0.5° per decade and in total knee excursion by 0.5-0.8° per decade.[5] Finally, increasing gait speed resulted in significant increases in angles and excursion of all joints assessed.

Existing Research on Prefabricated C-AFOs

Generally, prefabricated orthoses of various types are frequently used for common pathology presentations due to their ease of use and relatively low cost. Clinically, these devices may be billed as off-the-shelf or custom-fit, the latter requiring "more than minimal self-adjustment" and the expertise of a certified clinician per the Medical Directors of the Durable Medical Equipment Medical Administrative Contractors.[8] Incorporating the dynamic, stiffness, and light weight properties of carbon composites into the design of ankle foot orthoses (AFOs) has resulted in a ubiquitous nature of C-AFOs in various rehabilitation settings. With numerous manufacturers producing prefabricated C-AFOs and the frequency of their use, clinicians must have appropriate knowledge of how each orthosis will affect patient gait.

Currently, many clinicians rely on the knowledge that most C-AFOs are relatively similar functionally and mostly vary only in design. Design variations among manufacturers include cuff placement (anterior/posterior), strut placement (medial, lateral, posterior), strut design, starting neutral angle, and carbon fiber composite blend (altering stiffness and energy return capabilities). Numerous studies have investigated the stiffness of C-AFOs.[9–12] However, unlike the current testing and manufacturing standards for carbon fiber composite prosthetic components, no testing standards exist for C-AFOs resulting in slight variations in reported stiffness.[9,13] When comparing five different stiffness tests on a variety of prefabricated C-AFOs from different manufacturers, Shuman et al found significant differences in the calculated rotational stiffness among all testing methods.[9] (See page 41.) While general trends in measured stiffness have been established, without standardization for C-AFO stiffness testing, it is impossible to generalize study results to all C-AFOs.

Medical practitioners and clinicians must be accurately informed on how custom orthoses compare to prefabricated orthoses both quantitatively and qualitatively in function. This can be achieved by comparing temporospatial gait parameters and joint angle data between prefabricated and custom orthoses. A study conducted in 2014 compared the use of custom thermoplastic AFOs to prefabricated C-AFOs used acutely post stroke. The data showed that both interventions significantly

Hip and knee joint position can impact ankle range of motion and muscle force production at the ankle and vice versa.

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While general trends in measured stiffness have been established, without standardization for C-AFO stiffness testing, it is impossible to generalize study results to all C-AFOs.

improved velocity, cadence, stride length, and step length when compared to conditions with no intervention. There was no significant variation between orthotic interventions functionally. However, the study found that participants significantly preferred custom orthoses over prefabricated devices in a 2:1 ratio. A qualitative survey showed that participants felt significantly safer, more comfortable, and better balanced in custom interventions. The survey also demonstrated a significant improvement in perceived ease of swing and aesthetic preference specifically with custom AFOs.[14] Further research is required to determine if the variation in gait parameter data between prefabricated and custom orthoses is statistically and clinically significant.

Previous research examining the efficacy of prefabricated C-AFOs has continuously supported their use in a variety of patient populations. In 2004, Danielsson et al examined the effects of prefabricated C-AFOs on energy expenditure in patients post stroke (average age 52 years). The researchers found that self-selected gait speed increased by 20% when patients wore C-AFOs as compared to no orthosis at all. They also determined that energy expenditure decreased by 12% with C-AFO use.[15] A subsequent study was conducted in 2019 with pediatric patients experiencing unilateral drop foot secondary to cerebral palsy. This study investigated the efficacy of 2 different prefabricated C-AFOs and determined that both orthoses improved toe clearance in swing phase and initial heel contact.[16]

Available data regarding joint kinematics suggests that AFOs created with carbon composites may improve joint range of motion and joint power generation. A 2007 study conducted in Switzerland examined the impact of AFOs on the gait of children with motor disorders such as myelomeningocele, arthrogryposis, and neuropathy. Each child was provided with both a custom solid ankle foot orthosis and a custom carbon strut orthosis, then allowed several weeks to acclimate to the device. Once familiarized with the devices, each child underwent 3D gait analysis with both interventions. In children with myelomeningocele, custom carbon strut orthoses significantly increased dorsiflexion and plantarflexion, power generation at the ankle, and hip flexion. Conversely, children with arthrogryposis multiplex congenita did not experience the same improvements.[18] This study shows that carbon fiber composites can be useful in improving the mobility of certain patient populations, but further investigation is required to better understand the applicability of these devices. In 2018, a systematic review of 27 studies evaluated available research examining the effects of various AFOs on the gait of post- hemiplegic stroke patients. Seven studies within the systematic review showed a significant improvement in peak ankle dorsiflexion throughout the gait cycle in patients with drop foot. All studies showed that any orthotic intervention at the ankle was better than having no intervention in relation to drop foot.[19]

Based on present findings, no studies have examined the effect of prefabricated C-AFOs on non-pathological gait. Most studies with C-AFOs have examined pathologic gait in a variety of populations[14–16] or have been conducted with custom fabricated thermoplastic AFOs utilizing carbon struts.[17,18] Consensus among researchers and clinicians is that C-AFOs are effective in improving gait parameters, reducing energy expenditure, and providing toe clearance in swing phase and effective propulsion at terminal stance.[14–19] Examining non-pathological gait provides foundational knowledge of the function of these devices by removing the extraneous variables presented by pathological gait abnormalities.

A Call for More Research

Although C-AFOs are readily available and frequently used in practice, there is still a need for foundational research pertaining to their effect on gait. Existing research has solidified the contributions of carbon composite materials in orthotic devices and demonstrated the efficacy of utilizing carbon composites in AFO design for select patient populations. However, the foundational understanding of how prefabricated C-AFOs as a group affect gait is still unknown. Additionally, while no testing standards exist for C-AFO manufacturing and testing, existing research and understanding of their functioning remains relative and lacks impact.

Future research should collect data regarding gait parameters and joint kinematics to demonstrate the functional effect of these devices on gait. Studies involving a greater variety of patient populations are needed to determine C-AFO efficacy as current research is not generalizable. Research should be conducted with numerous manufactured options, rather than just 1 or 2, to provide generalizable conclusions across C-AFO options. Testing protocols must be explicitly defined, especially regarding material properties, due to the variability amongst testing options. Finally, gathering information in non-pathological patients can provide foundational knowledge regarding the effects of these devices.

Only with stronger research backing can clinicians and healthcare professionals make

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appropriate decisions regarding which C-AFO will have the most appropriate impact on the gait and functioning of their patient. ler

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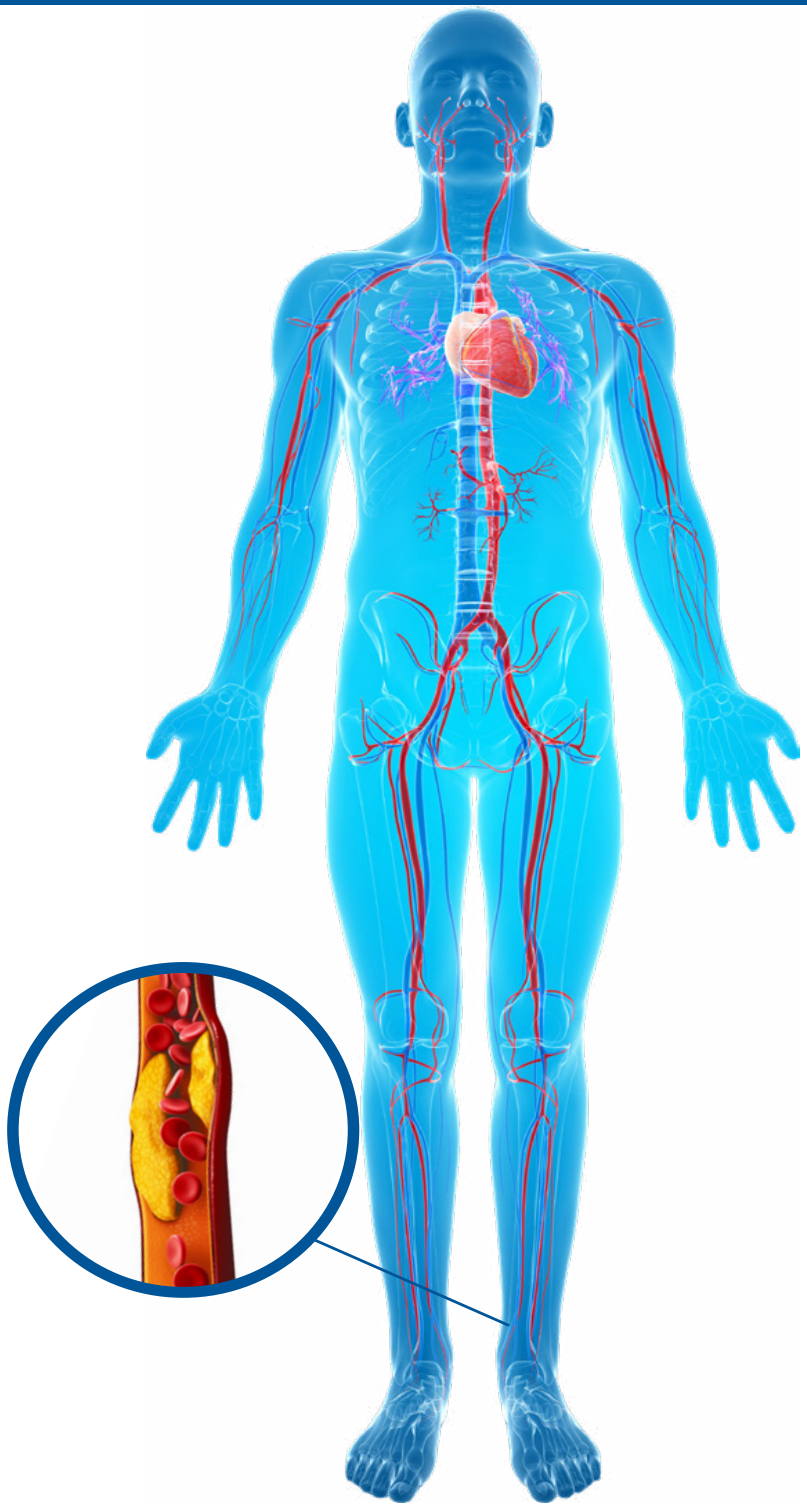

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Comparing 5 Methods for Evaluating Ankle–Foot-Orthosis Stiffness

By Benjamin R. Shuman, Deema Totah, Deanna H. Gates, Fan Gao, Andrew J. Ries, and Elizabeth Russell Esposito

Non-uniform measurement practices may limit the clinical utility of AFO stiffness as a metric in AFO prescription and future research.

Ankle–foot orthoses (AFOs) are external braces used to support or augment the ankle joint during activities of daily living. A wide variety of custom and commercial AFOs are available to accommodate each AFO user's individual needs. Differences among AFOs are largely driven by their geometry and mechanical properties. As such, evaluating AFO mechanical properties has received increasing attention in the literature. One of the more common mechanical properties evaluated is the rotational stiffness about the ankle joint, calculated as the change in resistive torque over the change in ankle angle.

Unlike prosthetics where testing standards have been established for prosthetic feet (e.g. ISO 10328 and ISO 22675), no such standards exist for AFOs. Some AFO manufacturers have attempted to adapt these prosthetic standards for AFOs, but the field largely lacks consistent methodology. Methodological differences include inconsistencies with mounting, alignment/bending axis, range of motion, and testing speed. Only 1 study has directly compared AFO properties with 2 devices across 3 AFOs. While similar stiffnesses were found in that study, it is unclear whether those results are generalizable across a range of AFO designs and materials or to other testing devices.

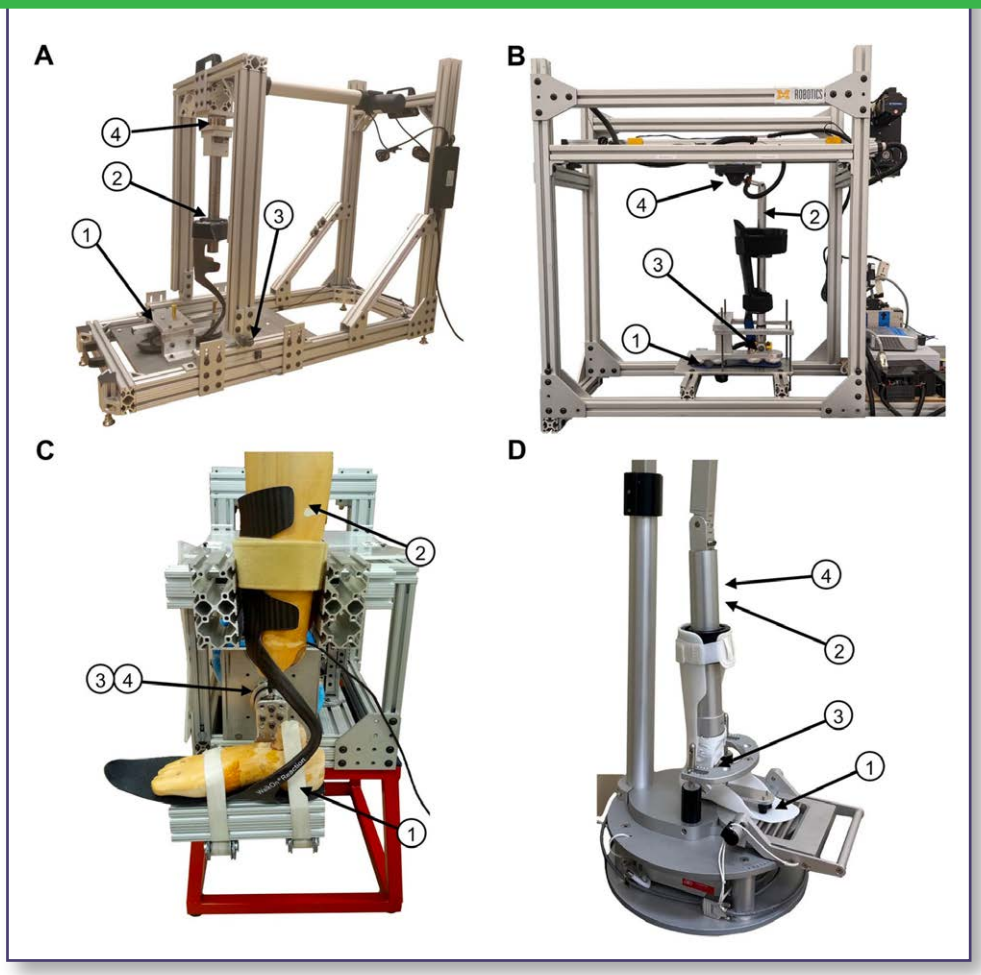

Figure 1. Overview of existing test fixtures. A. EMPIRE, B. SMApp, C. KST, and D. BRUCE. All fixtures secure the AFO for testing by clamping down the footplate using a mock/surrogate/test foot (1) and strapping the tibial cuff to a surrogate shank (2). Angular displacement of the AFO is measured at the axis of rotation using an encoder (3) and applied loads are measured using a load cell (4). Note that the AFO pictured in the BRUCE was not one tested in this study.

Thus, the goal of this study was to compare the stiffnesses of carbon composite AFOs evaluated using methodologies that have been reported in the literature. The first 4 methods were previously reported test fixtures evaluated for repeatability: The Bi-articular Reciprocating Universal Compliance Estimator (BRUCE), Kentucky Stiffness Tester (KST), the AFO Stiffness Measurement Apparatus (SMApp), and the device for Evaluating Mechanical Properties In Rotating Exoskeletons (EMPIRE). The fifth method manually measured the deflection of an AFO elicited from hanging weights (HW) off of the toe, similar to the approach used in previous studies.

This article has been excerpted from "Comparison of five different methodologies for evaluating ankle-foot orthosis stiffness" by the same authors, which was published in the *Journal of Neuroengineering and Rehabilitation*. 2023;20(1):11. doi: 10.1186/s12984-023-01126-7. Editing has occurred, including the removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License. Find the full article at https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-023-01126-7.

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Figure 2. Setup for hanging weight method. In this approach, an AFO is strapped to a surrogate shank and the footplate is clamped to a backing plate. Weights are hung from the AFO toe and the angle of deflection is measured with an inclinometer. Torque is computed from the applied load and the moment arm measured to the center of the surrogate shank.

Methods

Thirteen commercially available carbon composite, non-articulated AFOs were tested including: the Blue Rocker, Blue Rocker 2½, ToeOFF, and ToeOFF 2 ½ from Allard (Helsingborg, Sweden), the WalkOn Reaction and WalkOn Reaction Plus from Ottobock (Duderstadt, Germany), the SpryStep, SpryStep Max and SpryStep Plus from Thuasne (Levallois-Perret, France), and the Matrix, Matrix Max, Matrix Max2 and Matrix Supermax from Trulife (Dublin, Ireland). All AFOs except the Ottobock AFOs were the same specimens as previously reported in Shuman & Russell Esposito [*J Biomech Eng*. 2022;144:1–8.]. All AFOs were right foot models, size large. The same AFO specimens were independently evaluated by each methodology.

The 13 carbon composite AFOs were tested with five different methods. Four previously reported custom test fixtures (the BRUCE, KST, SMApp, and EMPIRE – Figure 1) rotated an AFO into dorsiflexion about a defined axis in the sagittal plane. The fifth method (HW

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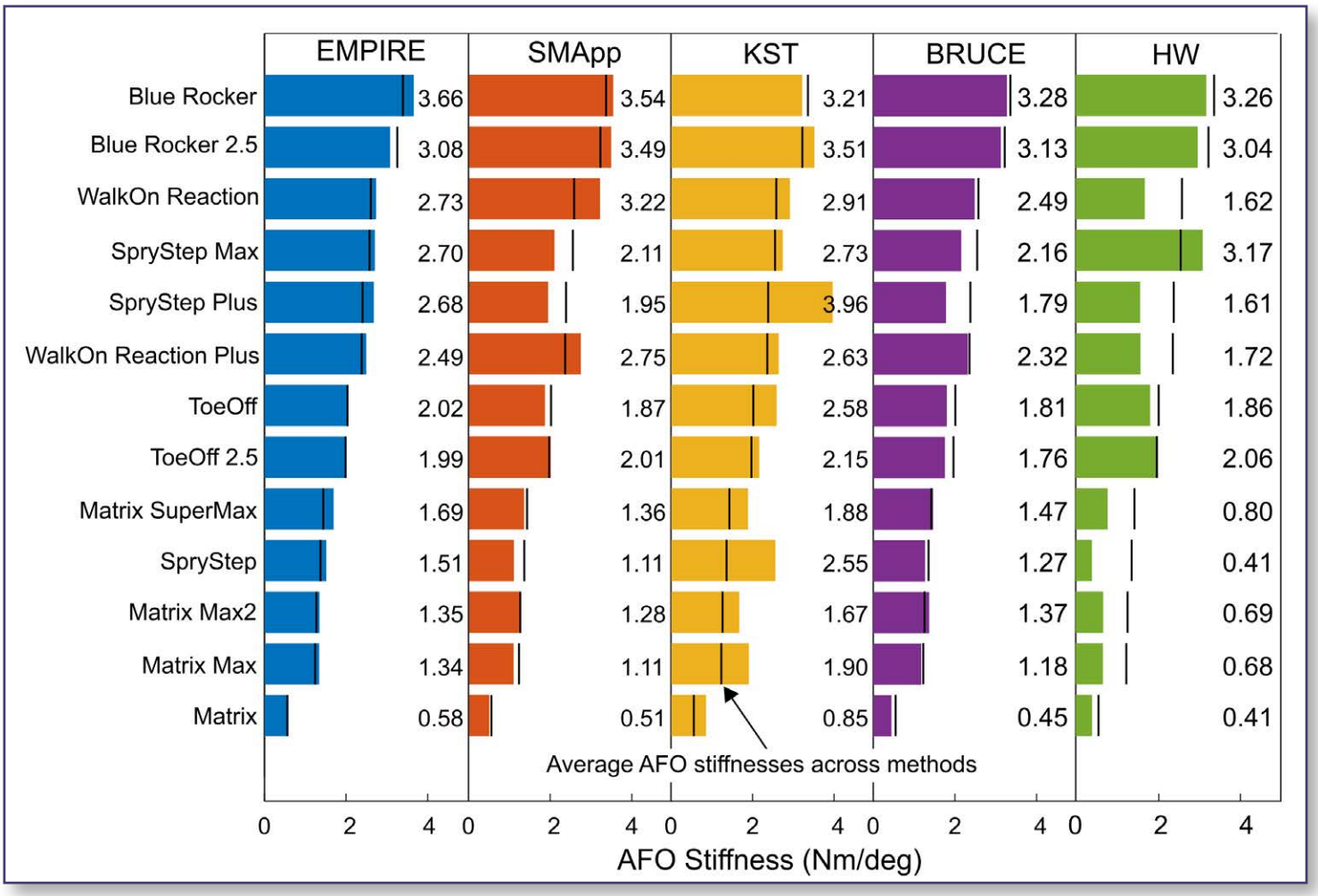

Figure 3. Measured AFO stiffnesses for each of the five test methods. AFOs are ordered from the largest average stiffness to the smallest average stiffness. Average stiffnesses across methods are indicated by an overlaid black line.

– Figure 2) involved quasi-static deflection of AFOs into dorsiflexion by hanging weights from the footplate. AFO rotational stiffness was calculated as the linear fit of the AFO resistive torque and angular deflection. Differences between methods were assessed using descriptive statistics and a repeated measures Friedman with post-hoc Bonferroni–Holm adjusted Wilcoxon signed-rank tests. *For greater detail on the methodology, please review the source article found at the URL at the bottom of the first page of this article.*

For the previously reported fixtures, we also computed the average stiffness for each AFO test session in each test method across all measured cycles. For each fixture we compared the differences in AFO stiffness across test sessions using descriptive statistics (median and range). Because the AFOs included span a range of stiffnesses, we report the relative percent differences in AFO stiffness across the sessions, computed as the range in measured stiffness divided by the average stiffness. For each AFO the ratio of the range in stiffness across fixtures to the largest intersession range of stiffness was computed.

For greater detail on the methodology and statistical analysis, please review the source article found at the URL at the bottom of the first page of this article.

Results

All stiffness devices measured a linear relationship between torque and displacement ($r^2 > 0.95$) for all trials (Supplemental files detailing specifics are available at the URL noted on the opening page of this article.)

Each method identified the Blue rocker as the stiffest AFO (except the KST, which ranked it third stiffest of 13), with stiffnesses ranging from 3.21 Nm/deg (KST) to 3.66 Nm/deg (EMPIRE) (Figure 3). All test methods identified the Matrix as the least stiff (0.41 Nm/deg, HW to 0.85 Nm/deg, KST). Across all AFOs, the median difference in absolute AFO stiffness between methods was 1.06 Nm/deg (range: 0.40 to 2.35 Nm/deg). The relative percent differences in stiffnesses was a median of 62% of the average stiffness across methods (range: 13% in the Blue Rocker to 156% in the SpryStep). With the HW method excluded, the median difference in absolute AFO stiffness between methods decreased to 0.52 Nm/deg (range: 0.38 to 2.17 Nm/deg) with relative

Continued on page 47

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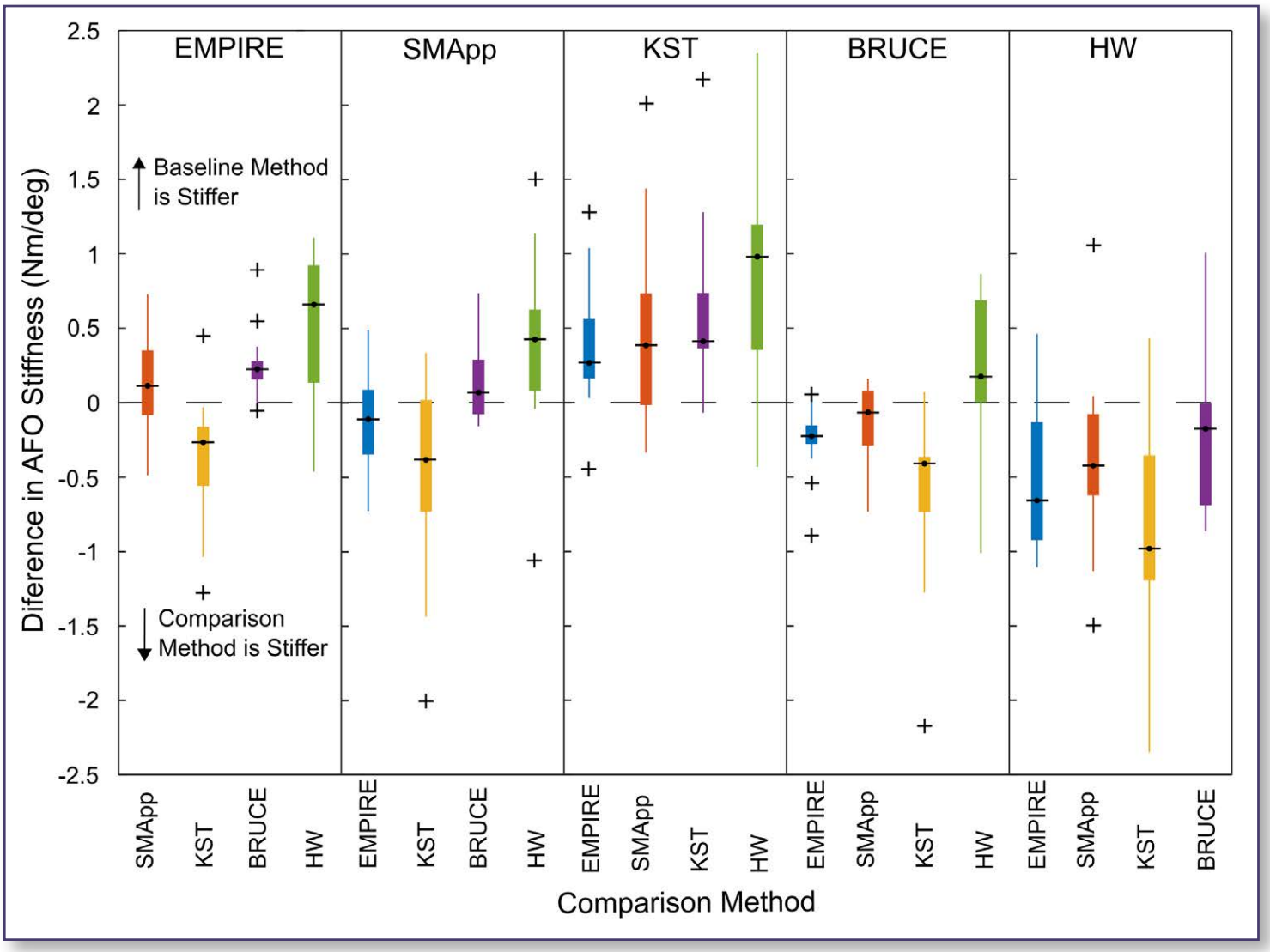

Figure 4. Box plot of differences in measured AFO stiffness between test methods. Each method is used as a baseline and compared to each of the other test methods, where the comparison method is indicated by color (blue: EMPIRE, red: SMApp, yellow; KST, purple: BRUCE, green: HW). Positive values indicate that the baseline method is stiffer than the comparison method. The KST measured stiffnesses are larger than any of the other test fixtures while the HW measured the lowest stiffnesses.

percent differences in stiffnesses a median of 27% of the average stiffness across methods (range: 13% in the Blue Rocker to 89% in the SpryStep).

Measured AFO stiffness was different across the test methods ($P < 0.001$) using a Friedman Test. The HW method produced the lowest stiffness values of any method, which were a median of 0.66 (IQR: 0.13 to 0.94), 0.42 (0.08 to 0.62), 0.91 (0.35 to 1.24), and 0.18 (0.01 to 0.67) Nm/deg lower than the EMPIRE, SMApp, KST, and BRUCE respectively (Figure 4). Statistically, the HW method was significantly lower than the EMPIRE ($P = 0.006 < 0.007 = \alpha/7$, Wilcoxon signed rank post-hoc), and KST ($P = 0.002 < 0.006 = \alpha/8$) but did not reach the corrected level of significance for the SMApp ($P = 0.027 > 0.013 = \alpha/4$) or the BRUCE ($P = 0.11 > 0.017 = \alpha/3$). The KST method measured stiffnesses were significantly greater than the BRUCE ($P < 0.001 < 0.005 = \alpha/10$) and the EMIRE ($P = 0.008 = 0.008 = \alpha/6$) by a median of 0.41 (0.36 to 0.74) and 0.27 (0.16 to 0.56) Nm/deg respectively, but not significantly greater than the SMApp ($p = 0.013 > 0.01 = \alpha/5$) by a median of 0.38 (-0.02 to 0.73) Nm/deg. Across the tested AFOs, the EMPIRE was not significantly different than the SMApp ($P = 0.27 > 0.05 = \alpha$) by a median of 0.11 (− 0.08 to 0.35) Nm/deg, and was stiffer than the BRUCE ($P = 0.001 < 0.006 = \alpha/9$) by a median of 0.22 (0.15 to 0.28) Nm/deg. The best agreement between any 2 fixtures' median values was between the SMApp and the BRUCE with the SMApp not significantly different ($P = 0.13 > 0.025 = \alpha/2$) with a median of 0.07 (− 0.08 to 0.29) Nm/deg.

Within each previously reported test fixture, median intersession ranges in stiffness were 0.27 Nm/deg in the EMPIRE, 0.11 Nm/deg in the SMApp, 0.11 Nm/deg in the KST,

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and 0.03 Nm/deg in the BRUCE.

Median relative percent differences in stiffness across sessions were 10% (range: 2 to 54%), 3% (< 1 to 14%), 5% (2 to 38%), and 1% (< 1 to 3%) for the EMPIRE, SMapp, KST, and BRUCE respectively. Differences in average measured stiffnesses across fixtures were a median of 2.06 (range: 0.97 to 5.60) times greater than the largest intersession differences for each AFO. Only the intersession differences in stiffness of the Matrix Max 2 (tested in the EMPIRE) were larger than the differences between fixtures.

Discussion

This study demonstrates significant differences in the calculated rotational stiffness of AFOs among 5 test methods. The BRUCE, KST, SMApp, and EMPIRE are all conceptually similar in their design and operation, constraining the rotation of an AFO about a single axis and deflection to the strut. While not all methods were significantly different from one another, these 4 previously reported test methods still had a median inter-method difference of 27% of the average measured stiffness.

A hanging weight (HW) method was included for its simplicity and similarity to previous reports in the literature, but was the most different from the other methods in design and produced the lowest measured stiffnesses. Unlike the other methods, the HW method imparted minimal constraints on the AFO's motion, resulting in a shifting center point of rotation. The lack of constraints in the HW method allowed the AFOs to experience out of plane rotations, without regard for anatomical motion. While neither the height of rotation, nor the out of plane rotations were quantified in this study, AFOs with lateral struts deflected into inversion and external rotation in addition to dorsiflexion, while AFOs with medial struts also deflected into eversion and internal rotation. These additional deflections may have contributed to the consistently lower stiffnesses measured by the HW method, especially for the less rigid AFOs. With the other 4 custom fixtures, 3 considerations were incorporated for consistency. First, AFO stiffnesses may be sensitive to rotational speed, thus, all test fixtures were operated at relatively slow speeds except the BRUCE, which is manually controlled. Second, the heights of the rotation axes were either mechanically or numerically adjusted to be similar (75–81 mm), as rotation axis may impact stiffness. Third, stiffnesses were all computed as the linear fit of the torque–angle curve while loading into dorsiflexion as previous work with these fixtures have computed stiffness differently, using quasi-static positions, the torque–angle during loading, and the average-torque angle during loading and unloading.

Differences in test fixtures and alignment practices exist, all of which may impact the measured stiffnesses. While the impact of each

methodological difference remains unclear, this study demonstrates that the cumulative impact of these differences can have large impacts on measured AFO stiffnesses. It is important to note that these methodological differences do not make one method more or less accurate than another as differences in kinematics and anatomy between AFO users may also impact the user experienced stiffness.

However, it is also still important to identify factors that can lead to consistency and inconsistency in testing outputs. Prior work has suggested that AFO users may be sensitive to differences in stiffness as small as 12%. Across the methods presented in this study we were only able to measure stiffness values that agreed within 15% of the average stiffness for 2 of the 13 AFOs tested, suggesting that if the goal of using stiffnesses to target AFO prescription is to be realized, uniform testing standards must be developed and adopted.

Conclusions

Quantitative measurements of the mechanical properties of AFOs promise to improve the prescription of AFOs by enabling direct comparisons across models and manufactures. However, this study highlights factors that may contribute to differences in testing outputs and demonstrates the fundamental importance of developing uniform testing standards, similar to those that exist for lower limb prosthetics. Lacking standardization, differences in fixturing and alignment practices may result in large differences in measured stiffness, limiting the potential clinical utility. ler

Prior work has suggested that AFO users may be sensitive to differences in stiffness as small as 12%.

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Young Children's Footwear: Taxonomy

By Cylie M. Williams, Stewart C. Morrison, Kade Paterson, Katherine Gobbi, Sam Burton, Matthew Hill, Emma Harber, and Helen Banwell

Footwear is a global business, with small and large companies co-existing, often purporting design differences or mechanical properties as their 'edge' within a competitive market. There is little consistency between commercial grade footwear brands for determinants of shoe sizing, and no universally accepted descriptors of common types or features of footwear. This can be problematic when specific footwear features are prescribed by health professionals as part of a therapeutic intervention.

Children's footwear plays an important role in protecting and supporting the growing foot. This is of particular importance in the younger child, from new walkers until around 6 years of age, as they typically engage in increasingly complex bipedal activities during a time of increased tissue plasticity. The purchase of children's footwear is a common source of angst for parents. This angst can be heightened when children present with disability or developmental concerns, where specific footwear features may assist in achieving, improving, or maintaining ambulation. The lack of consistency in descriptors of footwear types and features can stymie both health professionals and parents as it is typically dependent on the individual retail center to interpret prescribed or recommended inclusions.

The primary aim of this research was to develop a footwear taxonomy through international consensus about the types of footwear commonly worn by children under the age of 6. Secondary aims were to gain consensus of the common footwear features, when different types of footwear would be commonly worn, common terms for key footwear parts, and how movement at some of these footwear parts should be described.

Methods

Opinions were collected through a 3-round modified Delphi international online survey from parents, health professionals, researchers, and footwear industry professionals. There were 159 participants who consented to complete the first round. The first survey displayed generic pictures about different footwear types and asked participants to provide a grouping term, when the footwear would be worn (for what type of activity) and any grouping features. The second and third rounds presented consensus.

Results

There were 121 participants who provided detailed feedback to open-ended questions. The final round resulted in consensus and agreement on the names of 14 different footwear types (Figure 1), when they are commonly worn and their common features. Participants also reached consensus and agreement on the terms heel counter to describe the back part of footwear (Figure 2) and fixtures as the collective term for features allowing footwear adjustability and fastening. They also agreed on terms to quantify the flexibility at footwear sole (bend or twist) or the heel counter.

Discussion

This study offers the first taxonomy for young children's footwear developed by consensus in consultation with footwear industry professionals, health professionals, and parents. This work was undertaken to respond to persistent challenges with promoting clarity about footwear information, and transparency with footwear research. This taxonomy is a useful resource of contemporary terms and features of footwear, to guide terminology, research, and descriptors provided in clinical practice and footwear retail.

Footwear has long been considered a factor impacting on foot development alongside the attainment and improvement of motor skills. Footwear is an external factor that can influence children's gait and differences in motor skill, meaning that greater consideration of footwear recommendations for toddlers and young children are required. In recent years, the focus on footwear dimensions and fit has been explored but there has also been a shift toward understanding the effects of footwear characteristics on biomechanical outcomes and identifying what features should typify shoes for infants and young children.

Parents often report concerns about footwear choices for their children and health professionals have an important role providing footwear education for consumers, but especially parents. These findings are a prerequisite to conversations in practice about footwear choices for children and will assist clinicians with evolving and implementing age-appropriate footwear advice and helping parents to navigate footwear recommendations.

Conclusion

This taxonomy represents consensus amongst parents, health professionals, and footwear designers and retailers, and is an important step in enabling consistency in footwear research. One shoe does not fit all purposes, and the recommendations from this work help to inform the next steps toward ensuring greater transparency and commonality with footwear recommendations for parent. ler

This article has been excerpted from "Young Children's Footwear Taxonomy: An International Delphi Survey of Parents, Health and Footwear Industry Professionals," from the same authors, which was published in *PLoS ONE*. 2022 Jun 9;17(6):e0269223. doi: 10.1371/journal.pone.0269223. Editing has occurred, including the renumbering of tables and figures, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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Figure 1. Taxonomy and common features infographic.

https://doi.org/10.1371/journal.pone.0269223.g004

Figure 2. Footwear feature definitions infographic.

https://doi.org/10.1371/journal.pone.0269223.g005

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BOOK EXCERPT

Treating Injury Involves Gathering the History + Patient's Perspective

By Richard Blake, DPM

History of the Injury and the Patient's Own Reason Why They Were Injured

There are so many types of injuries, but we have to start putting together a good picture of what happened and can it be prevented in the future. You can actually have a positive impact on all the different types of injuries, at least in the rehabilitation, by knowing the most you can. I will start this discussion with the mnemonic that always runs through my head when I am taking a history (also included in Chapter 17). Common Historical Questions:

- **F** – Pain **frequency**; are there important **family history findings**?
- **A** – Patient's own **assessment**, what **activities** produce pain, what **activities** are okay?
- **I** – Pain **intensity**, is there a lot of **inflammation**?
- **L** – Pain **location**, **how long** does the pain last?
- **E** – What **eases** pain?
- **D** – What is the **duration** of pain?
- **N** – Does this problem feel like **nerves**, like **numbness**, etc?
- **O** – What are the events concerning the **onset** of pain?
- **P** – What **produces** the pain, past injuries involved?
- **Q** –W hat is the **quality** of the pain?
- **R** – Does the pain **radiate**, is there **redness**? Originally it was the **result** of what?
- **S** – How do **shoes** help or produce pain? Is there **swelling**? is there **stiffness**? Are there previous **surgeries** that may play a role?
- **T** – What **treatments** done? What **treatments** helped and hurt, any **tingling**?
- **U** – Does the patient have **underlying** problems?
- **V** – How does the pain **vary**?
- **W** – Has it affected **work**, is there **weakness**?

Most injuries are either acute (sudden onset of pain) or chronic (gradual buildup of pain). It is important with acute injuries to learn if there were circumstances that led to the injury, like generalized weakness from an illness leading to a fall. It could just be their 3rd or 4th ankle sprain with each one causing the ankle to get weaker and more unstable. The more you can make sense of the period surrounding the acute injury, the more you can help the patient rehabilitate fully and prevent the problem from occurring again.

I spend the most of my time dealing with either acute injuries from overuse (like a Jones fracture secondary to 10 days of basketball in 12 days), or just straight overuse where the weakest link in the chain starts complaining. Acute injury from overuse is where the athlete was overdoing activities and finally something (like a tear in the plantar fascia) started complaining. The patient can tell you exactly when they felt pain that has not gone away. Straight overuse typically presents as a gradual onset of pain that slowly worsens over time until it finally forces the patient to accept some restriction in activities and start some treatment. This is where an understanding of the weakest link in the chain concept is important. When we overdo activities, and our bodies start complaining in an area, something is making that area a weak link. Our job is to find out why.

Practical Biomechanics Question #53:

In a busy medical practice, an extensive history is normally done by a pre-visit questionnaire, with the provider glancing at the answers before delving more deeply with their own questions. In our mnemonic, what does the letter "F" stand for? ler

Richard Blake, DPM, MS, is adjunct faculty at the California School of Podiatric Medicine. He has practiced podiatry at the Sports and Orthopedic Institute of St. Francis Memorial Hospital in San Francisco, CA. His book, Practical Biomechanics for the Podiatrist, Book 1, is available from Amazon.com and Barnesandnoble.com, as well as from the publisher at bookbaby.com.

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NEW CLICK REEL

Click Medical, manufacturer of kits that adjust the fit and volume in custom orthotic and prosthetic (O&P) devices, announced that the NEW Click® Reel is now available and part of Click Medical RevoFit®, RevoLock®, and RevoSurface® Kits. The new device is stronger and more durable, it can quickly be tightened and loosened, and is guaranteed for the life of the device in which it is installed. Several improvements for the O&P industry were identified and developed in the new Click Reel including a more powerful drivetrain, intuitive interface, repeatable/reliable functionality, and easy lace attachment and replacement. As the final development stage, Click Medical completed an extensive 10-month long beta test which involved testing the device from the perspective of O&P practitioners, technicians, and patients. Practitioners and technicians tested the Click Reel for ease of fabrication, and patients gave feedback on fit, function, ease, and performance.

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UWF MASTER OF SCIENCE IN ATHLETIC TRAINING PROGRAM ACHIEVES ACCREDITATION

The University of West Florida's Master of Science in Athletic Training program recently earned accreditation from the Commission on Accreditation of Athletic Training Education (CAATE). After the comprehensive review, the program was granted the maximum initial 5-year accreditation.

The CAATE is a nonprofit organization serving the public and profession by establishing and ensuring compliance with accreditation standards that facilitate quality outcomes, continuous improvement, innovation, and diversity to enhance athletic training education. It is responsible for the accreditation of more than 260 professional athletic training programs, 7 post-professional degree programs, and 12 residencies.

UWF's Master of Science in Athletic Training program prepares students for successful careers in high school athletics, university athletics, professional sport teams, industry, medical clinics, and other settings. The athletic training graduate program meets local, state, and national needs for licensed, qualified athletic training professionals.

To learn more about the program, visit uwf.edu/msat.

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The evidence-based ACTIVATOR® Poles were designed by an occupational therapist and gerontologist specifically for rehabilitation and long-term conditions. This unique patented design enhances strengthening, stability, and off-loading with the user's safety in mind. The 2-section collapsible poles may be beneficial for pre/post hip or knee surgery (upon assessment of a rehabilitation professional), soft tissue injuries, patients with gait impairments, chronic pain, older adults, and more. The poles are equipped with a button locking system for greater weight-bearing capacity: maximum user weight 250 lb., weight bearing per pole 200 lb. The patented ergonomic Coregrip is designed for core strengthening, balance, and off-loading while reducing strain on the wrist. The bell-shaped tip provides stability and the wide ledge instead of a strap reduces the risk of injury. Three anti-vibration features minimize stress on joints. The poles are adjustable to user heights to 6' and ACTIVATOR 2 is 6'4".

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SMART INSOLE TO ID, MITIGATE WORKPLACE SLIPS, TRIPS, FALLS

Professor Lim Chwee Teck, PhDm from the National University of Singapore's (NUS) Department of Biomedical Engineering, collaborated with NUS start-up, FlexoSense, to develop a smart insole that can track workplace slips, trips, and falls (STFs) in real time. The insole will allow companies to identify the location of an incident and highlight STF risk areas to implement suitable mitigation measures.

The smart insole comprises pressure sensors to track foot pressure and an inertial measurement unit sensor to measure changes in motion. When an STF occurs, the body will initially try to maintain balance by exerting pressure on the feet to break the STF. The smart insole can pick up these unique changes in pressure, and a person's orientation, to determine if an STF has occurred. Such changes

The research team displays prototypes of the smart insole. Image courtesy of NUS.

are then recorded and measured in real time to generate balance profiles of different users, which could help in assessing the deployment of workers for various tasks. Additionally, falls from height can be detected by the smart insole as they have distinct velocity profiles compared to falls on level ground.

Information gathered from the smart insole can be easily accessed by workers through a mobile application and by company management via a dashboard. The digitalization of STF occurrences facilitates timely reporting and greater transparency on these incidents.

Beyond monitoring and reporting STFs, the smart insole recognizes daily activities including walking, standing, and sitting, allowing managers to identify potential risky actions such as when a worker should be walking instead of running, and to measure center of pressure to assess each worker's sense of balance.

THERASCOOP LATERAL TRAINER

Helix has launched TheraScoop, a professional upgrade to its bestselling Scoop Lateral Trainer, a therapeutic device designed to address chronic knee and hip pain at home. This compact lateral trainer was designed specifically for physical and occupational therapists with clinic-based or travel-based practices. This non-impact device weighs 28 pounds and measures 13 inches tall, allowing for use under a desk for most people. Lateral trainers are ideal therapeutic tools, particularly as pre-habilitation/rehabilitation for hip or knee arthroplasties, as well as for patients with impaired balance, or for those suffering from chronic knee, hip, or sciatica pain. Lateral trainers like the new TheraScoop are reportedly the only cardio modality to work the body in all 3 planes of human motion, thereby recruiting muscles other methods ignore, including those crucial to balance and knee support and stability.

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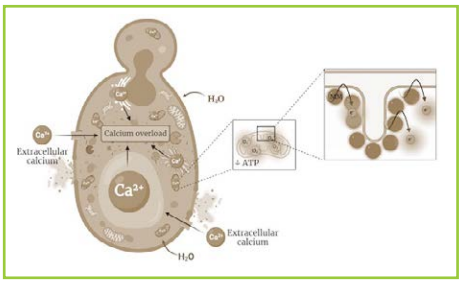
MOLECULAR MACHINES COULD TREAT FUNGAL INFECTIONS

That stubborn athlete's foot infection an estimated 70% of people get at some point in their life could become much easier to get rid of thanks to nanoscale drills activated by visible light. Proven effective against antibiotic-resistant infectious bacteria and cancer cells, the molecular machines developed by Rice University chemist James Tour, PhD, and collaborators are just as good at combating infectious fungi.

Based on the work of Nobel laureate Bernard Feringa, PhD, the Tour group's molecular machines are nanoscale compounds whose paddlelike chain of atoms moves in a single direction when exposed to visible light. This causes a drilling motion that allows the machines to bore into the surface of cells, killing them. In contrast to most antifungals, development of resistance to the visible-light activated nanoscale drills was not detected. Spinning at 2 to 3 million times per second, their rotors cause fungal cells to disintegrate by disrupting their metabolism.



Schematic representation of the mechanisms by which light-activated molecular machines kill fungi. Image courtesy of Tour Group/Rice University.

"Our molecules differ from conventional antifungals in that they specifically target what we call the powerhouses of the cell, that is, the mitochondria," said collaborator Ana Santos, a Rice alumna who is currently a Marie Curie Global Postdoctoral Fellow at Fundación Instituto de Investigación Sanitaria Islas Baleares in Spain. "By targeting the mitochondria, our molecules disrupt the cell's metabolism, resulting in an overall energy imbalance that leads to an uncontrolled flow of water and ions such as calcium into the cell, eventually causing the cell to explode," Santos explained.

CHILDREN'S WORKBOOK TO UNDERSTANDING PAIN

Ouch! Why Do I Hurt? is a workbook and guide that provides a fun, interactive way to teach children about how pain works and what to do about it. Studies show that when kids understand how pain works, they fear it less

and are more able to return to school and the activities they enjoy—which can help them start feeling better. This publication includes stories, metaphors, colorful illustrations, and activities to help teach kids about the body's nervous system. Children will learn how pain works and healthy ways to manage pain when they experience it. Writing, drawing, and coloring activities help kids discover steps they can take to start feeling better, while also improving comprehension of the information in the book.

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BYACRE CARBON FIBER ROLLATOR

Medline has expanded its portfolio of mobility products with the inclusion of the new byACRE Overland Carbon Fiber Rollator, a lightweight assistive walking device that is durable and agile enough to operate in snow, sand, and mud, as well as on sidewalks, curbs, unpaved trails, and thick grass. The rollator is the latest from byACRE, the Copenhagen-based international designer and producer of stylish mobility products. The rollator is equipped with pneumatic rubber tires. It's light, strong, and responsive enough to withstand every weather and terrain, allowing users to fully experience outdoor life. Assembled, the Overland Carbon Rollator weighs under 15 pounds, and also offers a shock-absorbing frame, integrated brakes with cables hidden in the frame for a sleek look, a built-in seat, and soft, ergonomic forward-pointing handles that add comfort while allowing easy maneuvering. byACRE rollators are available in a variety of colors.

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AI SOCKET DEVELOPED TO HELP TRANSFEMORAL AMPUTEES

The Korea Institute of Machinery and Materials (KIMM) has developed a smart, customizable prosthetic socket that automatically fills the socket with air upon detecting the empty space within in real time based on artificial intelligence (AI). This new technology, developed by senior researcher Kang-ho Lee's research team at the KIMM Department of Medical Devices can respond up to 15% of changes in the volume of the amputated area, which changes frequently depending on blood circulation, skin tissue condition, and nutritional status of the patient. Accordingly, the prosthetic socket relieves pain in the affected area by distributing the applied pressure while minimizing the socket's movement, which also serves to reduce fatigue while walking.

Image courtesy of KIMM

The research team made it possible to analyze the gait stability of the prosthetic user by linking the socket with a smartphone application so that the patient can monitor the pressure inside the prosthetic socket in real time. The user can also directly control the injection and discharge of air in the socket by setting the socket to either automatic or manual mode. The socket continuously measures the wearer's gait stability based on AI. As such, it greatly reduces any stress on the amputation site by controlling the volume of the prosthetic socket and modifying it in real time according to changes in the walking environment such as flat ground, stairs, or inclines, and changes in walking speed.

ROBOT PREVENTS FALLS, ASSISTS IN PHYSIOTHERAPY FOR THE ELDERLY

MRBA is a wearable assistive robot that can detect and prevent a fall before it happens, reducing the user's risk of sustaining injuries. Image courtesy of NTU Singapore.

Researchers at Nanyang Technological University, Singapore (NTU Singapore) and Tan Tock Seng Hospital (TTSH) have developed a wearable assistive robot that can detect and prevent a fall before it happens, reducing the user's risk of sustaining injuries. The robot can also be used to aid patients' rehabilitation from their injuries.

Called the Mobile Robotic Balance Assistant or MRBA (pronounced Mister-Bah), the robot uses inbuilt sensors to instantaneously detect a loss of balance and catches the user

with its attached safety harness, which is worn around the user's hips. The device would also help users who have difficulty in walking and balancing to stand up safely from a seated position, and to sit down safely from a standing position. It also uses a depth-sensing camera to observe the user's movements, while its machine-learning algorithms estimate the balance state of the user in real time to better predict any future imbalances or falls.

Intended for use with minimal caregiver help in both institutional and home settings, MRBA can assist people with limited or reduced mobility in day-to-day tasks, such as entering and exiting elevators, opening doors, getting dressed, and performing simple kitchen chores and tasks such as watering plants.

In clinical trials involving 29 participants, including patients who suffered from stroke, traumatic brain injuries, and spinal cord injuries, the researchers found that MRBA was successful in aiding them with sitting, standing, and walking, as well as assisting in tasks like fetching water. No falls were recorded in the trials, which spanned 3 days per participant.

LIFESTYLE SANDAL COLLECTION

Tread Labs, a performance insole brand established by Chaco founder Mark Paigen, is debuting its premium lifestyle sandal collection for men and women. This line is built upon the brand's "Your Support Group" system, providing unprecedented levels of comfort, pain relief, and performance. Specifically, the sandals feature: ultra-lightweight polyurethane midsoles sharing the DNA with performance running shoes; non-marking rubber soles with recycled content providing slip resistance and durability; contoured footbeds incorporating the proven arch support of Tread Labs' insoles providing transformative comfort; an aluminum buckle that is low-profile, non-slip, unbreakable, and secure; a water friendly profile that is machine washable; 3D knitted uppers using 100% recycled polyester; and micro-suede footbeds with anti-microbial treatment. Tread Labs sandals are guaranteed against defects in workmanship and materials for the useful life of the product and all outsoles may be replaced for an additional cost.

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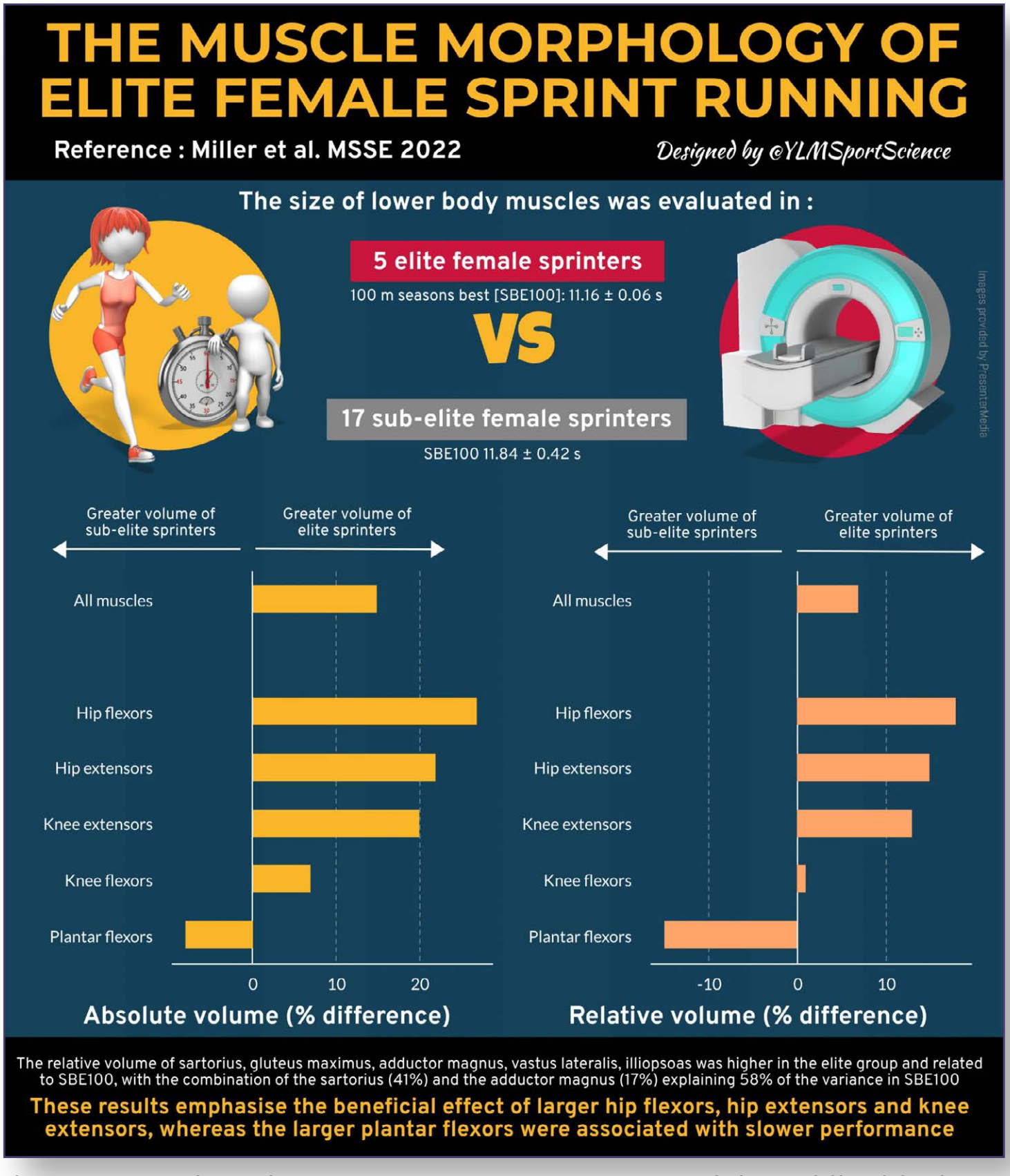

Source: Miller R, Balshaw TG, Massey GJ, et al. The muscle morphology of elite female sprint running. Med Sci Sport Exer. 2022;54(12):2138-2148. DOI: 10.1249/MSS.0000000000002999

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