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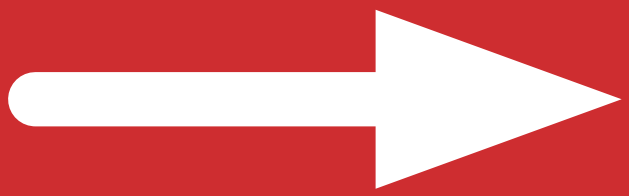

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Lower Extremity Review

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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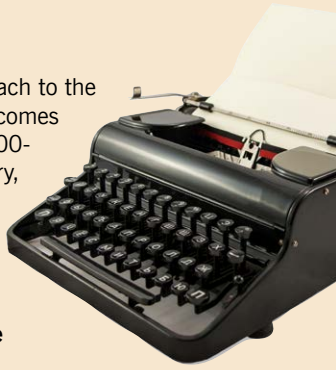

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Guest **Perspective**

Pickleball's Fast Growth and Game Pace Present Clinical Challenge

By Robert Weil, DPM

April is National Pickleball Month! And why shouldn't it be? The sport has exploded in popularity over the past decade or so—up more than 51% since August 2022 and 223% in 3 years![1] According to the *2023 Association of Pickleball Professionals Pickleball Participation Research,*[2] there are 48.3 million adult players in the United States—making it the fastest growing sport for the third year in a row! The report also noted that 19% of Americans have played pickleball at least once in the last 12 months—that's nearly 1/5th of the population.

The explosive growth in the sport, which by all accounts promotes both competitiveness and socialization, has been driven by surprising demographic changes in the player base, and a perhaps not so surprising response to the end of the isolation from the COVID-19 pandemic. While many think of pickleball as a game for seniors, that age group is no longer the primary cohort. Indeed, the *2023 State of Pickleball: Participation & Infrastructure Report*[1] found that the average age of today's pickleball participants is 35. While the 25-34-yr age group has the most participants, the 18-24 and 65+ age groups are now tied for the second highest participation rates. Clinical translation: *Everybody is playing pickleball*!

The allure of this low-impact sport, especially for seniors, is obvious: there isn't a lot of running, but there is a lot of competition. Pickleball is PHYSICAL! Think tennis and racquetball – lots of quick movements, starts and stops, multiple directions. Given the sport's explosive growth, today's clinicians can expect clients of all ages to report playing. Here are some principal factors to pay attention to: patient history, shoes and equipment concerns, and injury prevention and common lower extremity injuries.

1. Patient's Medical history. Whenever patients report starting a new activity, it's important to get or update their history. Key to starting this kind of racquet sport is physical joint and muscle history, body type, and most important, foot mechanics. Does the client have flat, hyper-pronated or high arch feet? Is the client bow-legged or knocked kneed? Are there problems with arthritis? Because pickleball is physical and multi-directional, the history of the foot, ankle, knees, hips, and back is key! And of course, the upper extremity is important, too. This history helps identify existing and potential weak links in the kinetic chain and provides an opportunity to talk about how to prevent injuries (Hint: stretching, keep reading).

2. Shoes, Socks, and Paddles. Like all sports and physical activities, proper shoes are key. Proper fitting of shoes is also of major importance. It surprises many that almost 50% of individuals do not have correctly fitting shoes, especially in width. There are plenty of "pickleball shoes" on the market today (unlike 3 years ago!), but clients need to make sure the heel is snugly secure in the shoe and that it provides overall lateral stability due to the types of movements the sport requires.

Socks are key too. The innovations that have rocked athletic clothing overall are indeed reaching all the way down the leg to socks and it's to patients' benefit. Arch support, motion & friction control, odor control, compression for the foot and lower leg are now all common place in the internet/social media marketplace and clinicians would be advised to familiarize themselves with the countless offerings as a means of helping patients with their footcare needs. You don't have to know them all, but having a couple

to recommend can go a long way to prevent problems. (More on sock innovations to come in an upcoming issue!)

To avoid upper extremity issues, players should pay attention to the paddle they are using and make certain the weight, the grip, and the overall size are correct for their musculoskeletal needs and their style of play.

3. Injury Prevention: Start with Stretching Like most racquet sports, pickleball uses the whole body, so warming up all the body parts first is a good idea. Our friends at Silver Sneakers[3] recommend thinking about the lower back, hip, knee, ankle and shoulders when warming up for pickleball. They encourage a 5-minute pre-game workout that includes:

a) Modified Bird Dog for the lower back
b) Walking Lunge for hips and knees
c) Step Out-and-In with Calf Raises for lower legs and ankles or Staggered Stance Heel Raises
d) Trunk Twists for spine and upper back
e) Side Lunges for inner thighs and hips
f) Resistance Band Pull-Aparts for shoulders

4. Injury Prevention: Brace for It! Common injuries across age group include sprains/strains, fractures, and contusions, with ankle sprains and knee injuries leading the way. Players should be advised to wear proper bracing for these areas if there is a history of problems.

Overuse injuries can be a problem as well. These are often related to what I call "the terrible 2s" – 2 much – 2 aggressive – 2 often. These are warning signs to back off and allow proper recovery. Plantar fasciitis, Achilles, lower leg, shin and knee tendinitis are all conditions caused, aggravated, and perpetuated by multiple direction, start and stop sports like pickleball – particularly when foot mechanics are faulty. Often my famous "Intelligent Rest" recommendations make good sense – trying to play through injuries or mask them with over-the-counter pain meds is not smart! Injury concerns of these types need to be identified and treated promptly, especially in older players.

Conclusion

1. Be aware that pickleball is physical – players should be in fairly good physical condition before they start. I stressed this in 2021 on these very pages[4] BEFORE the medical and physical therapy community knew how to spell p-i-c-k-l-e-b-a-l-l!
2. Advise players to pay attention to and identify previous joint or muscle problems. Strengthening all lower extremity – core, hips, knees, and ankles – makes big sense. If needed, physical therapists or athletic trainers can provide guidance.
3. Encourage players to pay attention to proper shoes and proper fitting of said shoes.
4. Lastly, but more importantly, encourage players to have fun and enjoy the physical activity this new trend offers. ler

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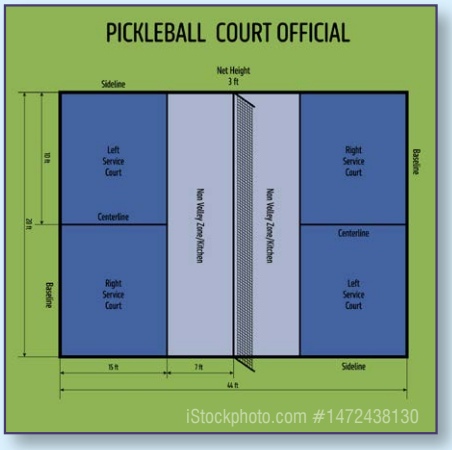
Robert A. Weil is a sports podiatrist in private practice in Lisle, Illinois. He hosts "The Sports Doctor," a live weekly radio show on bbsradio.com. His book, #HeySportsParents written with Sharkie Zartman, is available on Amazon.com. Dr. Weil was inducted into the prestigious National Fitness Hall of Fame in April 2019. This article updates one written by Dr. Weil in our May 2021 issue.

SO WHAT IS PICKLEBALL?

For the unfamiliar, it's a mash-up of tennis, badminton, and table tennis played on a badminton-size court (Figure) with a ping-pong type paddle, a whiffle ball, and a net. For an interesting history, including the origins of the name, and discussion of the rules, read "Pickleball: injury considerations in an increasingly popular sport" by Nicholas Greiner.[5] ler



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2024 AAOS Meeting Highlights

Meeting Highlights from the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons

YOUNGER AGE OF PRIMARY ACL INJURY, DECREASED TIME TO RETURN TO SPORT SIGNIFICANTLY INCREASES RISK OF SECONDARY ACL INJURY IN ADOLESCENT ATHLETES

In adolescent athletes who underwent anterior cruciate ligament reconstruction (ACLR), the younger the athlete at the time of primary ACLR and an earlier return to sport (RTS) were significantly associated with an increased rate of secondary ACL injuries, according to a new study presented at the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS). The study, "Predictors of Anterior Cruciate Ligament Reinjury and Return to Sport in Adolescent Athletes," found that when the age of primary ACLR increases by one year, the rate of secondary ACL injury decreases by 29% and a one-month delay in RTS decreases the rate of a secondary ACL injury by 17%.

"In our practice, we noticed we are seeing a larger prevalence of ACL injuries in this younger population, but we haven't seen literature that specifically looks at the high school age population," said Bhargavi Maheshwer, MD, lead author and third-year orthopaedic surgery resident at University Hospitals in Cleveland, Ohio. "Many of these athletes were returning for revisions or second opinions after having a retear or a contralateral ACL tear, so it is important to outline the trends behind the risk of having an ACL reinjury. Specifically, the variables that are associated with the higher risk of sustaining these injuries and what can we do from a patient education standpoint to address those variables."

ACL injuries in adolescent athletes are increasing mainly due to the rise of younger athletes playing in competitive sports at an earlier age and an increased awareness of ACL injuries.

For younger athletes, an ACL injury can have a major impact. For example, there is significant downtime associated with an ACL tear, which may lead to mental health issues; they are 10 times more likely to develop early arthritis; and there is a 25% to 35% increased risk of experiencing a secondary ACL tear. Additionally, up to 14% of adolescents who undergo ACLR do not return to their previous level of play.

The researchers sought to identify recent epidemiologic trends of ACL injuries and recurrent tear rates in high school athletes, and determine variables related to sustaining a secondary ACL injury. Using a prospectively maintained database from a single institution, the team retrospectively reviewed data for all patients under the age of 18 who underwent primary ACLR from 2015-2020. Patients were eligible if they were 13-18 years old, participated in a high school sport, and underwent evaluation and primary ACLR at a single institution. To be included, patients had to have a follow-up duration of 6 months or more and had not undergone a prior revision ACLR.

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Outcomes included postoperative complications, re-operations, time to RTS (defined as the number of months following ACLR until the patient was cleared to return to the sport by the operating surgeon), and time to retear or reinjury. Odd ratios were calculated for baseline patient characteristics and the association with the risk of retear. Multivariate Cox regression analysis was performed to identify the relationship between retear and potential risk factors. The results included:

- A total of 431 adolescent patients were included with a median follow up of over 5 years – 20.2% (87) sustained a secondary ACL injury and 79.8% (344) did not.
- Nine percent (39) of patients with a secondary ACL injury experienced a graft failure and 11.2% (48) had a contralateral ACL injury (ACL injury on the uninjured knee).
- Complication rates were low (n=22, 6.1%), with 11 patients experiencing arthrofibrosis (3%), 1 patient (0.2%) with a superficial wound infection managed with antibiotics and 1 patient (0.2%) with deep infection that required operative irrigation and debridement.
- Patients with a secondary ACL injury were older than those who did not have another ACL tear (mean age at surgery 16.2 ± 1.3 years versus 15.6 ± 1.5 years, respectively, p=0.003).
- After adjusting for all variables, a younger age at primary ACLR and time to RTS were significantly associated with an increased rate of secondary ACL injury.

"Nine months is the minimum that we consider it safe to return to sport following ACLR as a rapid return to sport puts you at greater risk of a recurrent injury," said James Everett Voos, MD, FAAOS, orthopaedic surgeon, chairman of orthopaedics at University Hospitals and head team physician for the Cleveland Browns. "For our younger athletes, we should take the time to ensure they are fully recovered and have had a chance to rehabilitate since they are often skeletally immature and still growing. As orthopaedic surgeons, we need to customize the treatment plan for each athlete as not all ACLs are the same, and counsel patients about their type of injury and when to return to the sport based ontheir rehabilitation and age."

INCREASED FRACTURE RISK FOR OLDER PICKLEBALL PLAYERS

Pickleball has become one of the fastest-growing sports in America, and with its increased popularity, the number of associated injuries has also risen. A new study presented at the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS), "Trends in Pickleball-Related Fractures in the United States: An Analysis of the 2002-2022 National Electronic Injury Surveillance System (NEISS) Database" found that there was a 90-fold increase in fractures over the past 20 years and most occurred in players ages 60-69.

The Sports and Fitness Industry Association identified an 11.5% average annual growth rate of pickleball players over the past 5 years, with approximately 1.4 million "core" players (those who play more than 8 times per year) in 2020.

"To date, there weren't any studies with a detailed analysis of pickleball-related fractures," said Yasmine Ghattas, a fourth-year medical student at the University of Central Florida College of Medicine. "With paucity in the literature, we wanted to determine the risk factors and prevalence of demographic variables associated with more serious injuries such as fractures since these can lead to hospitalization and surgery."

The research team used the Consumer Product Safety and Commission's publicly available database, NEISS, to compare a sample of data from 2002 to 2022 to identify pickleball-related fracture trends, mechanisms of injuries, anatomic locations and gender distributions.

A highlight of findings from the study include:

- Throughout the study, there was a 90-fold increase in fractures, with a noticeable surge from 2020 onward where fractures doubled.
- The fractures most observed were of the upper extremity in women aged 65+ following a fall, potentially reflecting diminishing bone health of this postmenopausal population.
- Despite the female predominance in fractures, men were 2.3 times more likely to be admitted for a fracture. This may be a consequence of the anatomic locations and subsequent severity of their

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fracture which often included lower extremity fractures of the hip, femur, and some truncal fractures.

- Interestingly, there were significant age differences in men who were discharged from the emergency room and admitted to the hospital, which was not found in women.

"Despite its reputation as a low-impact sport, pickleball can pose serious risk for players especially if they have weaker bones from osteoporosis," said Kurt P. Spindler, MD, FAAOS, orthopaedic surgeon at Cleveland Clinic in Florida. "It's important to understand your risk profile of injury and to speak with your physician to see how you can lower your risk. For example, if you know you're at risk for weakened bones, it's important to build your bone mass as you age with appropriate nutrients such as calcium and Vitamin D and choosing weightbearing activities."

See also "*Guest Perspective*: Pickleball's Fast Growth and Game Pace Present Clinical Challenge," on page 8.

SPORTS INJURIES IN 65 AND OLDER PROJECTED TO GROW BY 123% BY 2040

According to new data presented at the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS), sports injuries in seniors have increased significantly from 55,684 in 2012 to 93,221 in 2021 in the United States with significant differences in the types of activities and injuries. The study, "Orthopaedic Sports Injuries in an Aging Population: Currents Trends and Future Projections," also projected a 123% increase in sports-related orthopaedic injuries in those ages 65 and older from 2021 to 2040 while the number of orthopaedic surgeons is only projected to increase by 7.9% during that same timeframe.

"In practice, we are seeing adults in their 80's and 90's participating in activities that weren't previously of interest to them, such as pickleball," said Jay Zaifman, MD, lead author and orthopaedic surgery resident, NYU Grossman School of Medicine. "One of the top findings from our research is a clear potential for disparity between the number of orthopaedic surgeons and the increasing need for treating older adults experiencing sports injuries. There are traditionally different protocols and treatments for this age group. We now need to consider the new higher demands of many of these patients. Taking a patient-centered approach and rethinking our standard of care for more active older adults is crucial."

Through a retrospective cross-sectional epidemiological study, the researchers looked at sports-related injuries in patients 65 years and older between 2012-2021 in the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) database. The NEISS collects data from 100 hospitals that act as a nationally representative probability sample of all US hospitals with emergency rooms. Population estimates and projections were obtained from the US Census Bureau, collecting projections through 2040. The Physician Compare Database was used to estimate the total number of orthopaedic surgeons in the US.

Highlights of the data include:

- Sports-related injuries in elderly became more common from 2012-2021
  - There were an estimated 772,973 total sports-related injuries in seniors from 2012-2021, with a mean age of 73.0 (45% female). There was a significant increase in the national incidence of sports-related orthopaedic injuries in the elderly from 134 per 100,000 people in 2012 to 167 per 100,000 people in 2021.
- 123% increase in sports-related injuries in the elderly by 2040
  - It is projected that the total number of sports-related orthopaedic injuries will reach 137,852 by 2040, an increased rate of 4.7 injuries per 100,000 people per year. This shows that older people are getting injured more frequently during sports, they are participating in more sports and/or they are participating in different sports in which they are more likely to get injured.
- Demand for orthopaedic surgeons may outpace availability
  - The number of orthopaedic surgeons increased from 21,419 in 2016 to 22,206 in 2023, a 3.7% increase. The researchers projected 23,527orthopaedic surgeons in 2040, which represents a large disparity based on the increased demand for orthopaedic surgeons.
- Higher participation in sports by elderly

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  - A significantly higher proportion of injuries was associated with biking and scooters and less were associated with dancing and skiing in those 65 and older in 2021 than in 2012. This corresponds to an increase in the popularity of certain sports like cycling and higher participation rates among older adults.
- Elbow and upper leg injuries increasing
  - In 2021, there was a higher proportion of elderly sports-related injuries to the elbow (5.3% vs. 3.2%) and upper leg (4.2% vs. 2.1%) presenting to the emergency room compared to 2012.
- Higher rates of fractures
  - Fractures, hematomas, and avulsions were more common injuries in emergency rooms in 2021 than 2012, while strains/sprains and lacerations were less common.

To account for the impact that the COVID-19 pandemic had on sports-related activities, 2012 was compared to 2019, which showed proportionally less skiing-related injuries and more upper leg and spine injuries than in 2012. Strains/sprains and lacerations were also less common in 2019 than in 2012.

"While we don't have the data on this, we can extrapolate that it is very unlikely there were actually fewer sprains and strains that occurred in 2021 when compared to 2012," said Dr. Zaifman. "The patients may be going to their primary care doctor or they're seeing an outpatient orthopaedic surgeon for these injuries. Perhaps they are more aware that this isn't an emergent injury, or they're better educated on the proper location for treatment. It was emergent injuries like fractures that were presenting to the emergency room."

ROBOTIC ASSISTANCE IN CEMENTLESS TKA DOES NOT IMPROVE 2-YR REVISION RATES

As the use of robotic assistance in total knee arthroplasty (TKA) has grown, there has been limited research looking at whether it improved the risk of revision. New data showed that revision rates were similar in conventional and robotic-assisted cementless TKA at 2 years post-operatively. Presented at the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS), the study, "Effect of Robotic Assistance on Early Revisions and Aseptic Loosening in Cementless Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry," also found that the odds of revision due to infection or mechanical loosening were not significantly different between the 2 methods.

In 2017, more than 754,000 TKAs were performed in the United States. Bone cement is typically used to fix the implant to the bone;

however, cementless TKA has gained popularity as younger and more active patients undergo the procedure showing reduced surgery time and the potential to avoid cement fixation failure in the future. The use of robotic-assisted TKA has increased due to the potential for more precise, even bone cuts and a more accurate match with the implant dimensions.

"A lot of single surgeon studies show there is improved precision with robotic-assisted TKA," said Lucas E. Nikkel, MD, FAAOS, assistant professor of orthopaedic surgery, Johns Hopkins Medicine. "Some studies suggest there may be improved early recovery or less damage to soft tissue. One of the challenges with evaluating this is that many previous studies had significant financial conflicts of interest with the authors. We wanted to evaluate these questions using a registry study to eliminate the potential confounding factors to understand if there is a difference when this technology is applied to a surgery."

Using the American Joint Replacement Registry (AJRR), the researchers compared patients who underwent cementless TKA with robotic assistance versus without from January 2017 to March 2020, which included a minimum 2-year follow up. Data from patients aged 65 years and older was used due to the data linkage between AJRR and inpatient/outpatient Medicare claims data, which allowed the researchers to track patients if they switched hospitals. The primary and secondary outcomes were 2-year all-cause odds of revision between cementless TKA with or without robotic assistance and 2-year odds of the specific indication for revision surgery.

A total of 9,220 cementless TKAs were identified, with 4,120 (45%) performed with robotic assistance. Using a multivariable, mixed-effects logistic regression model, the findings, after controlling for cofounders, included:

- The odds of all-cause revision at 2 years following surgery were

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similar between the conventional and robotic-assisted cohorts (odds ratio 0.8, 95% CI .05 to 1.3; p=0.4).

- The odds of revision due to infection were similar between the 2 groups (OR 1.47 95% CI 0.8 to 2.6; p=0.19).
- Mechanical loosing was not significantly different between the cohorts (OR 3.2, 95% CI 0.8-12; p=0.09.

"Utilizing patients over age 65, we expected them to have higher failure rates as the potential for biologic fixation may be slightly lower," said Dr. Nikkel. "We found there was no significant differences in the risk of needing another operation within the first 2 years after surgery with a robotic-assisted or manual technique. This is significant in this population as the likelihood of an early failure is pretty much the same whether robotic assistance is used or not. Some patients desire a robotic-assisted TKA because they've heard it is better, but we've shown that there isn't a true benefit in terms of the likelihood of needing another surgery in the early period."

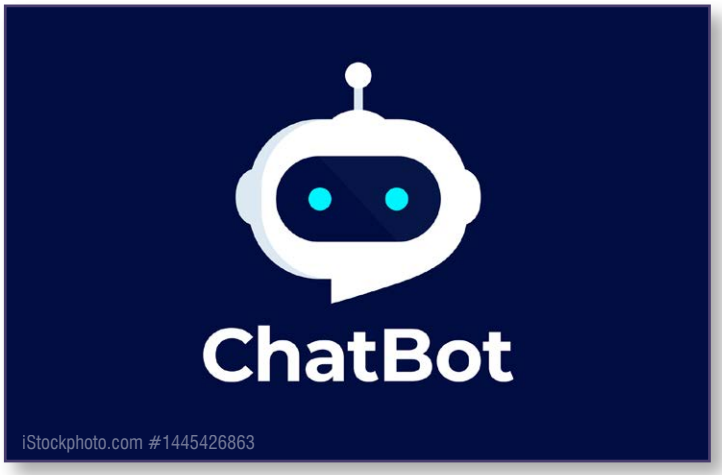
The researchers noted there were several limitations of the study, including the fact that national registries are reliant on the accuracy of data submitted, with 60% of AJRR TKAs not reporting if robotic assistance was used or not, and younger patients were excluded from this study. ler

AI CHATBOTS PROVIDE INCONSISTENT ACCURACY FOR MUSCULOSKELETAL HEALTH INFORMATION

- Researchers agree: Orthopaedic surgeons remain the most reliable source of information
- All chatbots displayed significant limitations, omitting critical steps in workup
- Researchers summarize: ChatGPT is still not an adequate resource to answer patient questions; further work is needed to develop an accurate orthopaedic-focused chatbot

With the growing popularity of large language model (LLM) chatbots, a type of artificial intelligence (AI) used by ChatGPT, Google Bard ,and BingAI, it is important to outline the accuracy of musculoskeletal health information they provide. Three new studies presented at the 2024 Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS) analyzed the validity of the information chatbots gave to patients for certain orthopaedic procedures, assessing the accuracy of how chatbots present research advancements and clinical decision making.

While the studies found that certain chatbots provide concise



summaries across a wide spectrum of orthopaedic conditions, each demonstrated limited accuracy depending on the category. Researchers agree that orthopaedic surgeons remain the most reliable source of information. The findings will help those in the field understand the efficacy of these AI tools, if the use by patients or non-specialist colleagues could introduce bias or misconceptions, and how future enhancements can make chatbots a potentially valuable tool for patients and physicians in the future.

STUDY OVERVIEWS AND OUTCOMES

Potential misinformation and dangers associated with clinical use of LLM chatbots

This study, led by Branden Sosa, a fourth-year medical student at Weill Cornell Medicine, assessed the accuracy of OpenAI ChatGPT 4.0, Google Bard, and BingAI chatbots to explain basic orthopaedic concepts, integrate clinical information, and address patient queries. Each chatbot was prompted to answer 45 orthopaedic-related questions spanning categories of "Bone Physiology," "Referring Physician," and "Patient Query" and then assessed for accuracy. Two independent, blinded reviewers scored responses on a scale of 0-4, assessing accuracy, completeness, and useability. Responses were analyzed for strengths and limitations within categories and across chatbots. The research team found the following trends:

- When prompted with orthopedic questions, OpenAI ChatGPT, Google Bard, and BingAI provided correct answers that covered the most critical salient points in 76.7%, 33% and 16.7% of queries, respectively.
- When providing clinical management suggestions, all chatbots displayed significant limitations by deviating from the standard

Continued on page 23

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Continued from page 20

of care and omitting critical steps in workup such as ordering antibiotics before cultures or neglecting to include key studies in diagnostic workup.

- When asked less complex patient queries, ChatGPT and Google Bard were able to provide mostly accurate responses but often failed to elicit critical medical history pertinent to fully address the query.
- A careful analysis of citations provided by chatbots revealed an oversampling of a small number of references and 10 faulty links that were nonfunctional or led to incorrect articles.

Is ChatGPT ready for prime time? Assessing the accuracy of AI in answering common arthroplasty patient questions

Researchers, led by Jenna A. Bernstein, MD, orthopaedic surgeon at Connecticut Orthopaedics, sought to investigate how accurately ChatGPT 4.0 answered patient questions by developing a list of 80 commonly asked patient questions about knee and hip replacements. Each question was queried 2 times in ChatGPT; first asking the questions as written, and then prompting the ChatGPT to answer the patient questions "as an orthopaedic surgeon." Each surgeon on the team evaluated the accuracy of each set of answers and rated these on a scale of 1 to 4. Agreement was assessed between the 2 surgeons' evaluation of each set of ChatGPT answers. The association between the question prompt and response accuracy were both assessed using 2 means of statistical analysis (Cohen's kappa and Wilcoxon signed-rank test, respectively). The findings included:

- When assessing the quality of the ChatGPT responses, 26% (21 of 80 responses) had an average scale of 3 (partially accurate, but incomplete) or less when asked without a prompt, and 8% (6 of 80 responses) had an average grade of less than 3 when preceded by a prompt. As such, researchers summarized that ChatGPT is still not an adequate resource to answer patient questions and further work to develop an accurate orthopaedic-focused chatbot is needed.
- ChatGPT performed substantially better when appropriately prompted to answer patient questions "as an orthopaedic surgeon" with 92% accuracy.

Can ChatGPT 4.0 be used to answer patient questions concerning the Latarjet procedure for anterior shoulder instability?

Researchers at the Hospital for Special Surgery in New York, led by Kyle Kunze, MD, assessed the propensity for ChatGPT 4.0 to provide medical information about the Latarjet procedure for patients with anterior shoulder instability. The overall goal of this study was to understand whether this Chatbot could demonstrate potential to serve as a clinical adjunct and help both patients and providers through providing accurate medical information.

To answer this question, the team first conducted a Google search using the query "Latarjet" to extract the top 10 frequently asked questions (FAQs) and associated sources concerning the procedure. They then asked ChatGPT to perform the same search for FAQs to identify the questions and sources provided by the chatbot. Highlights of the findings included:

- ChatGPT demonstrated the ability to provide a broad range of clinically relevant questions and answers and derived information from academic sources 100% of the time. This is in opposition to Google, which included a small percentage of academic resources, combined with information found on surgeons' personal websites and larger medical practices.
- The most common question category for both ChatGPT and Google was technical details (40%); however, ChatGPT also presented information concerning risks/complications (30%), recovery timeline (20%), and evaluation of surgery (10%). ler

CHANGES IN FOOT POSTURE IN CHILDREN WITH CP

Researchers from the Department of Orthopaedics at the Nemours Children's Hospital Delaware (Wilmington, DE) wanted to understand the change in dynamic foot posture in children with cerebral palsy. They were able to track 33 children (54 limbs) who completed 16.9 evaluations from an initial age of 2.9 (±0.7) yrs to 18.6 (±1.7) yrs. They found that early valgus foot posture normalizes in children at Gross Motor Function Classification System levels I/II and persists in children at levels III/IV who do not have foot surgery. They concluded that foot posture in young children with cerebral palsy begins in valgus and tends to normalize in youth who walk without an assistive device. They recommend conservative management of foot deformity in early childhood for this population.

Sources: *Church C, Lennon N, Lennon M, et al. Changes in foot posture evaluated with dynamic pedobarography over the course of childhood in ambulatory youth with cerebral palsy. J Child Orthop. 2024;18(1):3-12. doi: 10.1177/18632521231208746.*

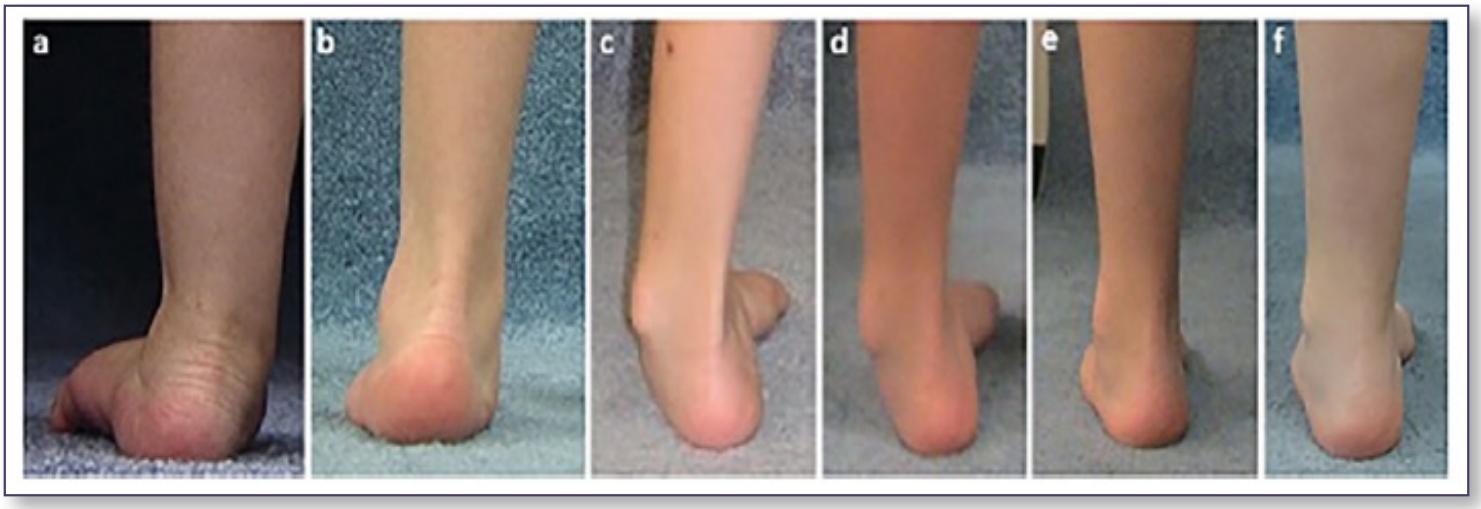

Figure. This girl presented at 2 years of age with a hemiplegic pattern, walking without external support. The main concern was (a) the severe left planovalgus foot, which was treated with a solid AFO. By age 4 years, the planovalgus was a (b) little better and the hinged AFO was continued. From age 4 to 6 years, her AFO was weaned as her foot improved, but then it continued into (c) varus. This required her to return to the AFO use until age 8 years when (d) the deformity was becoming more stiff with reduced AFO tolerance. At age 10 years, she had a gastrocnemius lengthening and a split tibialis posterior transfer. By age 14 years, she is brace-free with (e) improved foot posture, which continued to be (f) maintained with mild further improvement at age 12 years. This pattern of foot posture development from age 2 to 20 years is especially unpredictable in the younger ages.

CRANBERRY EXTRACT IMPROVES RUNNERS' SPEED

Competitive athletes are always looking for an extra edge to help improve performance. According to a new study by Concordia researchers published in the journal *Physical Activity and Nutrition*, they can find one in the common cranberry. Cranberries have the highest polyphenol and antioxidant capacity among fruits and vegetables and may protect against exercise-induced free radical production, consequently improving performance.

In a series of trials involving trained distance runners, the researchers found that ingesting a cranberry supplement for 28 consecutive days led to noticeable improvements in both performance and

Continued on page 27

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muscle fatigue following 1,500-meter time trials. Reoxygenation rates were faster and running speeds improved by 1.5%.

"When it comes to elite athletes, any advantage can make the difference between finishing fifth or on the podium," said Andreas Bergdahl, an associate professor in the Department of Health, Kinesiology and Applied Physiology and the paper's senior author.

The researchers recruited 14 high-level runners from Concordia's varsity track and field team and from two Montreal running clubs, who are performing at least 5 hours of endurance training a week.

The athletes ran 2 time trials over 3 separate visits, one a 1,500-meter, the other a 400-meter. The first visit was used as a baseline. At the second, they were given a single large dose of cranberry extract 2 hours before running. The athletes were then instructed to consume a small dose of cranberry extract daily for 28 days, after which they repeated the runs for a third time.

"We selected these distances to test the effects the cranberry extract had on different energy systems" said Francis Parenteau, a PhD candidate and the paper's lead author. "The 400-meter is shorter and of higher intensity and involves the anaerobic system. The 1,500-meter uses the aerobic system but is shorter than what the athletes usually run. Since they do not train to run that distance, we were able to isolate training effects as a variable."

Besides running time, the researchers measured post-exercise blood lactate, a marker for potential muscle fatigue and lack of oxygen. They also attached a portable near-infrared spectroscopy device to the runners to measure muscle oxygenation levels before, during, and after their runs.

Following data analysis, the researchers found that 28 days of cranberry extract consumption demonstrated a trend toward increased speed in the 1,500-meter time trial but not in the 400-meter. However, they did notice that lactate buildup was reduced following the 400-meter but not the 1,500-metre compared to baseline.

The data also indicated that the cranberry extract promoted better oxygen extraction by the muscle, improved lactate clearance and slower muscle deoxygenation.

Cranberries are extraordinarily rich in polyphenols, a natural compound with antioxidant properties. These characteristics help protect the body from the harmful effects of free radical molecules produced by strenuous exercise.

"The beauty of this is that it is all natural," says Bergdahl. "It is an ergogenic aid, meaning that it is performance-enhancing, but it is not an anabolic steroid. Athletes can get this important boost in their performance just by consuming more cranberries."

Sources: *Parenteau F, Puglia VF, Roberts M, Comtois AS, Bergdahl A. Cranberry supplementation improves physiological markers of performance in trained runners. Phys Act Nutr. 2023 Dec;27(4):8-14. doi: 10.20463/pan.2023.0032.*

LOW ANNUAL REVISION RATE IN ANKLE DISTRACTION FOR ANKLE OSTEOARTHRITIS

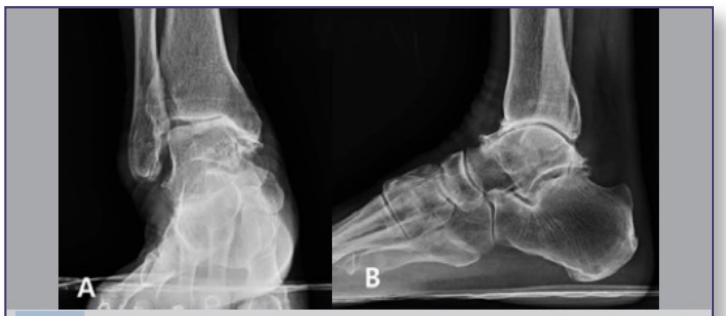

Figure 1. Plain radiographs showing end-stage arthritis in the ankle joint through anteroposterior (AP) view (A) and lateral view (B).

Image reprinted from Kim JB, Lee BJ, Jung D, Jeong U, An CH. Comparing outcomes of the ankle arthrodesis by using two different materials via a transfibular approach. Acta Ortop Bras. [online]. 2020;28(2):55-9. Use is per Creative Commons License 4.0.

Ankle osteoarthritis severely impacts patients' mental and physical quality of life. Besides total ankle replacement and ankle arthrodesis, ankle distraction has been shown to be a promising alternative. The primary aim of this systematic literature review and meta-analysis was to determine the annual revision rates (ARRs) after ankle distraction. The secondary aim was to obtain an overview of patient-reported outcome measures and functional outcomes.

Researchers from the Netherlands conducted a literature search up to November 2023. Methodological quality was assessed using the methodological index for non-randomized studies criteria. Primary outcome was the ARR which was log-transformed and pooled using a random effects model. Secondary outcomes were pooled using a simplified pooling technique and included the American Orthopaedic Foot & Ankle Society Ankle-Hindfoot Scale (AOFAS), range of motion (ROM) and post-operative complications.

The literature search resulted in 287 articles, of which 10 studies, comprising 602 patients, were included. The patients had a pooled mean age of 47 years (range of means: 40–68) and a mean follow-up of 35 months (range of means: 24–48). The overall methodological quality was moderate to fair. The pooled ARR after ankle distraction was 4% (95% confidence interval [CI], 3%–7%). Pooling of AOFAS showed mean 26-point improvement (from 54 to 80). Additionally, ROM dorsiflexion improved at 5°, and the plantarflexion remained at 31°. The overall complication rate was 41% (95% CI, 35%–48%), of which 77% (95% CI, 67%–85%) were pin-tract infections.

The authors concluded that ankle distraction results in an ARR of 4% (95% CI, 3%–7%) with clinically relevant improved AOFAS scores. The overall complication rate is 41% and is mainly attributable to treatable pin-tract infections (77% of recorded complications).

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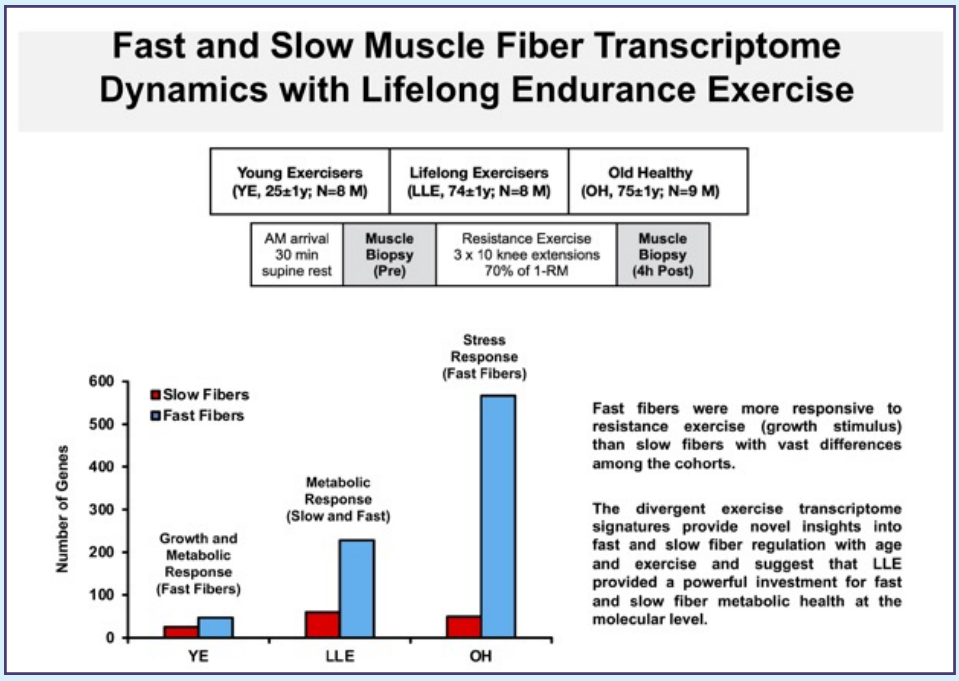
STUDENTS' BACKPACK LOAD IMPACTS STAIR DESCENT GAIT

Investigators from Shaanxi Normal University in China studied the impact of increasing backpack load on the gait of adolescents during stair descent. Sixteen healthy male students (age = 12.9 ± 0.6 years) were required to descend the stairs in 4 loaded conditions. The kinematic, kinetic, and EMG data were collected synchronously and gait parameters, especially indicators of balance control, were analyzed. The posterior tilt angles (Center of Mass [COM]-Center of Pressure inclination angle in the sagittal plane) (0 %-42 %, 48 %-53 %, 58 %-91 %, $p < 0.01$), trunk anterior tilt angles (9-33 %, 51-65 %, $p < 0.01$), and coefficient of variance of stride length ($p < 0.01$) increased with the backpack load. The COM-Step edge separation decreased with the increased backload ($p < 0.01$). In addition, the hip flexion torque (25-40 %, 45-51 %, $p < 0.01$), the rectus femoris activation, and the hip stiffness increased significantly as the load up to 15 % Body Weight (BW) and 20 % BW. The increasing backpack load may affect adolescent's stair descent gait. Especially as the load was up to 15 % BW, the adolescents' bodies tended to tilt backwards relative to the support foot during the single stance phase. They may activate the hip flexors and tilt forward the trunk to recover from the balance perturbation, which was associated with increased hip flexion torques. This adjustment was more pronounced with the increasing backpack load. However, excessive forward flexion may increase the risk of forward falls. The boundaries of adjustment need further research in the future. Findings from this study provide baseline information on the intrinsic mechanisms of balance control during stair descent.

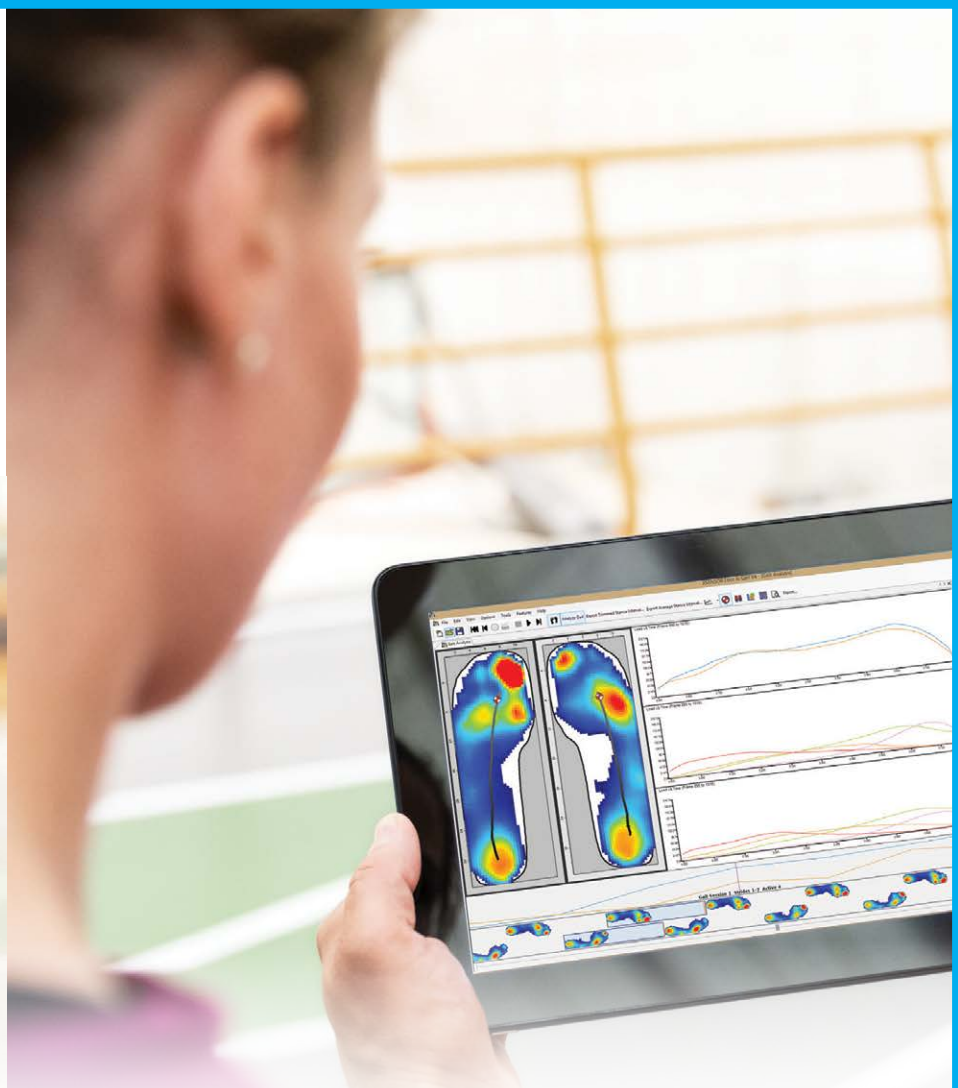
Sources: *Parenteau F, Puglia VF, Roberts M, Comtois AS, Bergdahl A. Cranberry supplementation improves physiological markers of performance in trained runners. Phys Act Nutr. 2023 Dec;27(4):8-14. doi: 10.20463/pan.2023.0032.*

WHO KNEW? LIFELONG EXERCISE AFFECTS MUSCLE FIBERS



This study provides the first insights into fast and slow muscle fiber transcriptome dynamics with lifelong endurance exercise. The fast fibers were more responsive to exercise with divergent transcriptome signatures among young exercisers (growth and metabolic), lifelong exercisers (metabolic), and old healthy nonexercisers (stress). Only lifelong exercisers had a biological response in slow fibers (metabolic). These data provide novel insights into fast and slow muscle fiber health at the molecular level with age and exercise.

Source: *Raue U, Begue G, Minchev K, et al. Fast and slow muscle fiber transcriptome dynamics with lifelong endurance exercise. J Appl Physiol (1985). 2024;136(2):244-261. doi: 10.1152/japplphysiol.00442.2023.*



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Lawn Mower-Related Lower Extremity Injuries Treated at United States Emergency Departments

By Mathias B. Forrester, BS

Background: Millions of people in the United States (US) have lawn mowers. Consequently, thousands of people visit US hospital emergency departments (EDs) each year for lawn mower-related injuries. The intent of this study was to characterize lawn mower-related injuries treated at US hospital EDs.

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

Results: Of an estimated 1,919,146 total lawn mower-related injuries, 440,433 (22.9%) involved the lower extremity. Of these lower extremity injuries, the affected body part was 29.8% lower leg, 19.4% ankle, 16.3% foot, 15.4% knee, 14.2% toe, and 5.0% upper leg. The injuries were 21.3% laceration, 21.1% strain or sprain, 15.0% fracture, 12.7% contusion or abrasion, 3.5% amputation, 3.1% puncture, and 23.4% other/not stated. The patient disposition was 90.4% treated or examined at the ED and released, 1.7% treated and transferred to another hospital, 7.0% treated and admitted for hospitalization, 0.4% held for observation, 0.6% left without being seen/against medical advice, and 0.1% not recorded.

Conclusion: Over one-fifth of all lawn mower-related injuries treated at US hospital EDs involved the lower extremity. The most commonly reported injuries were laceration, strain or sprain, and fracture. The majority of patients were treated or examined at the ED and released.

Lawn mowers are common household machines used in the United States. In 2020, 228.73 million Americans owned lawn and garden equipment.[1] There are a variety of types of lawn mowers. Walk mowers are machines that the operator walks behind and pushes. Types of walk mowers include reel or cylinder mowers, which have vertically rotating cylindrical blades at the front of the mower that cut against a fixed blade; rotary mowers, which have a single blade that rotates at very high speed in a horizontal motion; and push mowers, which require the operator to manually push the mower forward. Riding mowers or lawn tractors are machines that the operator rides. Lawn mowers may be manually powered, electric, gas-powered, or battery-powered.[2] What most, if not all, lawn mowers have in common are sharp blades, moving parts, and being heavy, particularly riding lawn mowers (See box).[3]

Injuries may occur during use of or proximity to lawn mowers. Lawn mower injuries may occur under a variety of circumstances, such as falling off of the mower (while in use or stationary); rolling over or flipping over the mower while in use; moving the machine by lifting, loading, or unloading the mower; striking an object while riding the mower; servicing or repairing the mower; being run over or backed over by a mower; striking or being struck by the mower; being hit by debris from the mower; and contacting a hot part of the mower.[4-6]

Thousands of lawn mower-related injuries are treated at United States (US) emergency departments each year.[4-9] Lawn mower-related injuries include lacerations, strains or sprains, soft tissue injuries, fractures, burns, contusions and abrasions, and amputations.[4,5,7-9] Deaths have occurred.[5,7,10]

Lawn mower-related injuries may occur to all body parts, including the lower extremity.[4,5,7-9,11] The intent of this study was to char-

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

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Body part affected					
Lower leg	2,775	28.3	131,045	29.8	109,315-152,775
Ankle	1,799	18.4	85,248	19.4	70,159-100,338
Foot	1,694	17.3	71,590	16.3	58,562-84,619
Knee	1,469	15.0	67,967	15.4	55,493-80,441
Toe	1,595	16.3	62,705	14.2	51,044-74,366
Upper leg	465	4.7	21,877	5.0	16,954-26,799
Type of injury					
Laceration	2,118	21.6	93,832	21.3	77,469-110,194
Strain or Sprain	1,975	20.2	92,781	21.1	76,573-108,988
Fracture	1,520	15.5	66,065	15.0	53,884-78,246
Contusion or abrasion	1,185	12.1	56,080	12.7	45,456-66,705
Amputation	511	5.2	15,197	3.5	11,510-18,884
Puncture	298	3.0	13,524	3.1	10,158-16,889
Other/not stated*	2,190	22.4	102,954	23.4	85,255-120,654
Total	**9,797**		**440,433**		**378,441-502,424**

No. = Number

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

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

*Includes avulsion, burn, crushing, dermatitis/conjunctivitis, dislocation, foreign body, hematoma, hemorrhage, nerve damage, not stated.

acterize lawn mower-related lower extremity injuries reported to US hospital EDs.

Methods

Data for this descriptive study were downloaded from the National Electronic Injury Surveillance System (NEISS) website at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS database has been described in detail in *Lower Extremity Review* previously.[12] In brief, the NEISS collects data on consumer product-related injuries from the EDs of approximately 100 hospitals as a probabilistic sample of the more than 5,000 hospitals with EDs in the US. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample.[13,14]

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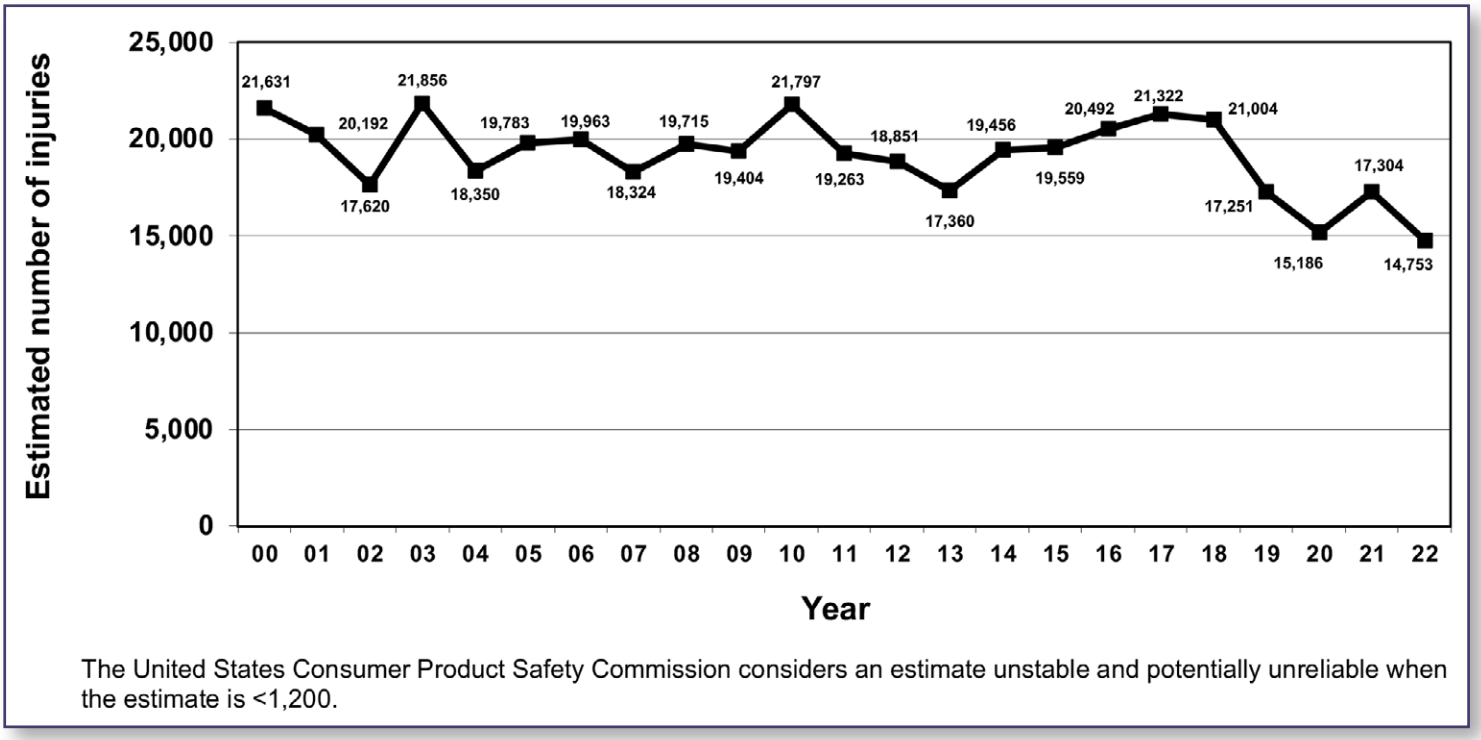

Figure 1: Annual estimated number of lawn mower-related lower extremity injuries reported to the National Electronic Injury Surveillance System, 2000-2022

Since data are publicly available and de-identified, the study is exempt from institutional review board approval. Previous studies have used NEISS data to examine lawn mower-related injuries; however, none of these previous studies focused on lower extremity injuries.[4-7,9] Another study examined lawn mower-related injuries to the lower extremity but included cases from a single trauma center.[11]

Cases were lawn mower-related lower extremity injuries reported to the NEISS database during 2000-2022. The publicly available NEISS database contains 3 numeric fields for coding the product involved in the injury (Product_1, Product_2, Product_3). (The Product_3 field was added in 2018 although it does not appear to have been used until 2019.) The NEISS database was searched for all records that included the following 7 codes in any of the 3 product code fields: 1401 - Power lawn mowers (not specified), 1402 - Manual push mowers (unpowered), 1405 - Garden tractors, 1422 - Riding power lawn mowers, 1439 - Lawn mowers (not specified), 1446 - Reel power lawn mowers, 1448 - Rotary power lawn mowers. Only those records where the Body_Part numeric field (a field that documents the injured body part) contained codes for a lower extremity (upper leg, knee, lower leg, ankle, foot, toe) were included in the study. The NEISS database contains another numeric field for documenting whether a second body part was injured (Body_Part_2); however, this field was only added in 2018,[14] although this field does not appear to have been used until 2019. For consistency over the entire study period, the Body_Part field alone was examined. (Ninety-eight cases had a lower extremity coded in the Body_Part_2 field but not in the Body_Part field during 2019-2022 and were excluded from the study. In contrast, 4 records that included a lawn mower code in the Product_3 field but not the Product_1 or Product_2 fields were included.)

The variables examined were treatment year, month, and day of week; patient age, sex, and race; type of lawn mower involved, based on the product code; location where the incident occurred; type of injury (diagnosis); affected body part; and disposition. Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). For all lawn mower-related lower extremity injuries, the distribution of cases and national injury estimates were determined for the variables. National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database, and 95% confidence intervals (CIs) were calculated for the estimates. The CPSC considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.[13] For those variable subgroups where the estimate was <1,200, 95% CIs were not calculated.

Thousands of lawn mower-related injuries are treated at United States (US) emergency departments each year.

Results

During 2000-2022, 9,797 lawn mower-related lower extremity injuries were treated at a sample of US hospital EDs, resulting in a national estimate of 440,433 (95% CI 378,441-502,424) lawn mower-related lower extremity injuries. This represents 22.9% of the 1,919,146 total

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

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Patient age (years)					
0-5	338	3.5	9,836	2.2	7,203-12,469
6-12	414	4.2	14,356	3.3	10,829-17,882
13-19	799	8.2	31,670	7.2	25,033-38,306
20-29	1,130	11.5	52,160	11.8	42,156-62,163
30-39	1,575	16.1	72,019	16.4	58,925-85,113
40-49	1,745	17.8	78,917	17.9	64,777-93,057
50-59	1,664	17.0	75,417	17.1	61,807-89,028
60-69	1,114	11.4	54,600	12.4	44,209-64,990
70-79	721	7.4	36,973	8.4	29,441-44,504
80+	297	3.0	14,486	3.3	10,934-18,037
Patient sex					
Male	6,903	70.5	302,469	68.7	257,803-347,136
Female	2,891	29.5	137,875	31.3	115,181-160,568
Unknown	3	0.0	89	0.0	-
Race					
White	5,885	60.1	283,404	64.3	241,193-325,614
Black/African America	973	9.9	33,027	7.5	26,160-39,895
Asian	22	0.2	804	0.2	-
American Indian/Alaska Native	12	0.1	786	0.2	-
Other	301	3.1	9,371	2.1	6,833-11,908
Not stated	2,604	26.6	113,040	25.7	93,879-132,200
Total	**9,797**		**440,433**		**378,441-502,424**

Please see full footnote on Table 1.

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estimated lawn mower-related injuries affecting any body part. Among the estimated lower extremity injuries, the type of lawn mower associated with the injury was 92,133 (20.9%) riding lawn mowers or garden tractors, 76,964 (17.5%) power lawn mowers (not specified), 31,979 (7.3%) rotary power lawn mowers, 10,861 (2.5%) manual push mowers (unpowered), 1,109 (0.3%) reel power lawn mowers, and 227,387 (51.6%) lawn mowers (not specified).

Table 1 shows the distribution of lawn mower-related lower extremity injuries by diagnosis and affected body part. The most common types of injury were laceration, strain or sprain, fracture, and contusion or abrasion. The highest proportion of lower extremity injuries involved the lower leg followed by the ankle and foot.

There was a mean of 19,149 estimated lawn mower-related lower extremity injuries per year. The estimated annual number of lower extremity injuries ranged between 17,360 and 21,856 during 2000-2018 and between 14,753 and 17,304 during 2019-2022 (Figure 1). By 4-month period, the estimated number of lower extremity injuries was 60,652 (13.8%) in January-April; 290,977 (66.1%) in May-August; and 88,803 (20.2%) in September-December; 143,274 (32.5%) estimated lower extremity injuries were treated on Saturday and Sunday and 297,158 (67.5%) on Monday-Friday.

Table 2 presents the patient demographics of lawn mower-related lower extremity injuries. Patients age 30-59 years accounted for 226,353 (51.4%) of the estimated lower extremity injuries. The majority of patients were male, and most patients were White.

Table 3 shows the distribution of injuries by location of the incident and patient disposition. Of those injuries where the location of the incident was known, most occurred at home. The majority of patients were treated or evaluated at the ED and released.

Discussion

This study examined lawn mower-related lower extremity injuries treated at US hospital EDs. Such information is important because millions of people in the US have lawn mowers, and over the last 23 years, almost 2 million estimated lawn mower-related injuries were treated at US hospital EDs, making this a serious public health concern.[8] (See also "Lawn Mower Injuries Costly Public Health Concern" and "Riding Mower Injuries Major Cause of Pediatric Limb Loss".) This study found that over one-fifth of all lawn mower-related injuries involved the lower extremity.

The most common types of lower extremity injury were laceration, strain or sprain, fracture, and contusion or abrasion, accounting for 70% of all lower extremity injuries.

The most common types of lower extremity injury were laceration, strain or sprain, fracture, and contusion or abrasion, accounting for 70% of all lower extremity injuries. Amputations were relatively uncommon, though a recent study cited riding lawn mower injuries as the leading cause of major limb loss in young children in the US.[15] Most of the common types of injuries would not be expected to require extensive medical intervention. This is consistent with the observation that nearly 90% of patients with lawn mower-related lower extremity injuries were treated or examined and released from the ED. However, roughly 10% of patients were admitted or transferred to another hospital for more costly care.While the estimated annual number of lawn mower-related lower extremity injuries remained relatively stable during 2000-2018, the estimated annual number of injuries declined during 2019-2022. In March 2020, due to the COVID-19 pandemic, stay-at-home or lockdown orders were issued, and schools, businesses, and other facilities were closed or restricted, although these restrictions were lifted in subsequent months.[16] Declines in various consumer product-related lower extremity injuries treated at US hospital EDs were associated with the start of the COVID-19 pandemic in 2020.[17] However, the decline in lawn mower-related lower extremity injuries began in 2019, prior to the COVID-19 pandemic, and continued into 2021 and 2022, when the US had returned to a semblance of pre-COVID-19 conditions. Examination of data from subsequent years will determine whether this decline in lawn mower-related lower extremity injuries continues.

Other temporal patterns were found with lawn mower-related lower extremity injuries. The injuries were seasonal, with almost two-thirds of the injuries occurring during May-August. Weather in the US is warmer, and grass grows most, during those months. Although lawn mower-related lower extremity injuries were treated throughout the week, a higher proportion of the injuries were treated during Saturday and Sunday. This may be due to people most likely being off work on the weekend and thus having more opportunity to mow grass.

There were demographic differences in lawn mower-related lower extremity injuries. Over half of the injuries occurred in patients age 30-59 years, and two-thirds of the injuries occurred in male patients. Individuals in this age group and of this sex might be more likely to use lawn mowers or may be more likely to experience lower extremity injuries resulting in treatment at hospital EDs.

There are a variety of ways to reduce the risk of lawn mower-related injuries.[3] A lawn mower should undergo routine service. Prior to mowing, the area to be mowed should be examined for objects such as rocks or sticks, which then should be removed to prevent them from being thrown when the lawn mower runs over them. Proper gear, including closed-toed shoes that are slip resistant and possibly also long pants, safety glasses, and grip gloves, should be worn while mowing. The lawn mower's fuel and/or battery levels should be checked before starting. An examination should be made for any debris or other objects that may be stuck in the lawn mower and a long-handled item should be used to remove any stuck objects. Safety shields or other features attached to the

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

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Location of incident					
Home/manufactured (mobile) home	7,775	79.4	348,028	79.0	297,561-398,496
Other*	145	1.5	5,542	1.3	3,825-7,259
Not recorded	1,877	19.2	86,862	19.7	71,532-102,192
Disposition					
Treated or examined and released	8,574	87.5	397,957	90.4	341,226-454,687
Treated and transferred to another hospital	123	1.3	7,407	1.7	5,281-9,533
Treated and admitted for Hospitalization	1,001	10.2	30,788	7.0	24,302-37,274
Held for observation	42	0.4	1,547	0.4	810-2,285
Left without being seen/against medical advice	53	0.5	2,454	0.6	1,474-3,433
Not recorded	4	0.0	280	0.1	-
Total	**9,797**		**440,433**		**378,441-502,424**

Please see full footnote on Table 1.
*Includes farm/ranch, street/highway, other public property, school, place of recreation or sports.

lawn mower should not be altered or removed. Other safety tips include making sure another person knows the lawn mower is being used, never leaving a lawn mower unattended when in use, educating children about the dangers of lawn mowers, ensuring that all pets are inside when mowing, being careful when mowing on slopes, never mowing backwards because the lawn mower will be moving towards the feet, and not mowing on wet grass.

There are limitations to this study. Lawn mower-related injury cases were initially identified by selecting those records with any of the 7 codes for lawn mowers in the Product_1, Product_2, or Product_3 numeric fields. Records involving lawn mower-related injuries where none of these 7 codes were used would not be included in the analysis. Furthermore, records with any of the 7 codes for lawn mowers in the Product_1, Product_2, or Product_3 numeric fields where lawn mowers were not actually involved in the injuries would be included in the analysis. It should be noted that review of the Narrative text field found only 82 records included in the study that did not mention "mow," "lawn tractor," "garden tractor," "cutting grass," or "cutting lawn." Of these 82 records, 71 mentioned a "tractor" but did not specify the type of tractor.

Furthermore, the study only included

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injuries treated at hospital EDs. Information on injuries treated elsewhere might provide a more complete perspective of lawn mower-related injuries.

In conclusion, over one-fifth of all lawn mower-related injuries treated at US hospital EDs involved the lower extremity. The most commonly reported lower extremity injuries were laceration, strain or sprain, and fracture; amputations were relatively uncommon. The majority of patients were treated or examined and released. Lawn mower-related lower extremity injuries were seasonal, most often occurring in May-August. Persons with these injuries tended to be adults, particularly age 30-59 years, and most were male. ler

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

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Lawn Mower Injuries Costly Public Health Concern

A 2018 study from Johns Hopkins Surgery looking at 8 years of data found an average of 6,400 lawn mower injuries per year with an average cost of $37,000 per patient

In an unusually comprehensive analysis of nationwide data, researchers from Johns Hopkins Medicine concluded that the rate of lawn mower injuries persists at close to 6,400 a year, most of them requiring surgery and hospitalization, and costing an average of $37,000 per patient. The study, tracking 8 years of data between 2006 and 2013, was published in *Public Health Reports*.

"Despite consumer education programs and warning labels, lawn mower injuries in the United States remain a serious public health concern," said Deborah Schwengel, MD, assistant professor of anesthesiology and critical care medicine at the Johns Hopkins University School of Medicine and the study's senior author. She is also associated with Johns Hopkins Children's Center.

Overall, the Hopkins analysis showed that the most frequent injuries were to men (43,567 of 51,151, or 85.2%), and that **children up to age 4 were 6 times more likely to have a foot/toe or lower extremity injury and 1.7 times more likely to have an amputation than those age 15 and above**. Conversely, older teens and adults age 15 and above were 8.3 times more likely to have an injury to the hand or upper extremity. This, the researchers said, suggests that young children are more likely to get injured by running into the yard while a family member operates the lawn mower or by getting their foot trapped in the machine while sitting in the operating member's lap, and that the majority of teens and adults sustain injuries from sticking their hands into the mower to clear debris.

The data were not able to inform the researchers about the type of mower that caused an individual injury; what mower designs were most likely associated with injuries; or whether those injured were bystanders or doing the mowing.

Previous studies, says Schwengel, have generally collected data only on certain types of injuries associated with consumer products without addressing issues of cost or national scope.

To better understand the extent of the problem, Schwengel and her team drew on information gathered for the United States Nationwide Emergency Department Sample (NEDS), the largest emergency department database in the U.S. Overall, they focused on medical record reports of lawn mower-related emergency department visits and hospitalizations from Jan. 1, 2006, to Dec. 31, 2013. NEDS captures 25 million to 30 million emergency department visits, or 20% of all emergency department visits in the US, each year.

The researchers also collected age, geography, gender and other information about those injured, along with the day of week and month when each visit occurred.

For the analysis, the research team identified 14,878 lawn mower injuries over the 8-year period, which, when adapted to reflect national ER visit data, represented an estimated 51,151 injuries, and consisted of about 6,394 cases per year on average.

For the entire study population, most of the injuries were lacerations (23,907 of 51,151, or 46.7%), fractures (11,433 or 22.4%) and amputations (11,013 or 21.5%). The most common injury locations were wrist or hand (33,477, or 65.4%) and foot or toe (10,122 or 19.8%).

Of the 51,151 cases, 43,567 (85.2%) were in men; 19,162 (37.5%) happened in the South; 33,886 (66.3%) occurred on a weekday; and the majority, 36,686 (81.7%), occurred between April and September.

By looking at standardized injury codes, or E-codes, the researchers were able to look

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at national averages of treatment costs for the codes and determine that emergency room charges totaled an average of $2,482 per patient, and average inpatient charges totaled $36,987 per patient.

Schwengel and her colleagues caution that the study was limited to E-codes that are used by hospitals primarily for administrative purposes, and that the collection and reporting of these codes varies from state to state. However, they say the findings are comparable in outcome to previous studies, and that the NEDS data sample allowed for more in-depth analyses of charges, procedures performed and patient demographics for these types of injuries.

"Understanding what types of injuries occur in certain groups should help engineers design safer lawn mowers and policymakers create more appropriate prevention policies," said Schwengel. One example of a better lawn mower design that could prevent injury, the researchers said, would be one with stopping features that automatically activate when human flesh is detected near blades.

Source: *Hottinger DG, Nasr I, Canner JK, Kattail D, Koka R, Schwengel D. Incidence, distribution, and cost of lawn-mower Injuries in the United States, 2006-2013. Public Health Reports. 2018;133(5):570-577. doi:10.1177/0033354918785909. News report available at https://www.hopkinsmedicine.org/news/newsroom/news-releases/2018/09/lawn mower-injuries-a-persistent-source-of-serious-injury-and-high-costs-new-study-affirms.*

Table 1 Excerpt: National estimates of characteristics of lawn mower injury cases in the United States, based on data from 14878 patients in the Nationwide Emergency Department Sample, 2006-2013[a]

Characteristic	Weighted Estimate of Lawn-Mower Injury Cases, No. (95% CI) [%][b]	US Population, 2010 Census (%)[c,d]
Total	51 151 (49 422-52 879) [100.0]	308 745 538 (100.0)
Charges, $[j]		
Total ED charges	113 million (107 million-119 million)	—
Charge per ED visit, mean	2482 (2379-2585)	—
Total inpatient charges	177 million (152 million-202 million)	—
Inpatient charge per stay, mean	36 987 (33 065-40 909)	—
Hospital length of stay, median (mean) [95% CI]	2 (3.9) (3.5-4.3)	—

[a]Data source: Nationwide Emergency Department Sample. [b]Weights provided by the Healthcare Utilization Project in the data files were applied to obtain national estimates. [c]Data source: Howden and Meyer. [d]Data are provided in this column for characteristics that may be compared with US Census data; for characteristics where a comparison is not applicable, an em dash is used. [j]Charges adjusted for inflation according to the Consumer Price Index.

Riding Mower Injuries Major Cause of Pediatric Limb Loss

By Charles A. Jennissen, Treyton D. Krupp, J. Priyanka Vakkalanka, and Pamela J. Hoogerwerf

Background: Riding lawn mower injuries are the most common cause of major limb loss in young U.S. children. Our study objective was to investigate the circumstances surrounding pediatric riding lawn mower injuries and to identify potential contributing risk factors and behaviors leading to these events.

Methods: Followers/members of both a public and a private lawn mower injury support and prevention Facebook page who had or were aware of children who had suffered a lawn mower-related injury were invited to complete an electronic survey on Qualtrics. Duplicate cases and those involving push mowers were removed. Frequencies and chi-square analyses were performed.

Results: 140 injured children were identified with 71% of surveys completed by parents and 19% by an adult survivor of a childhood incident. The majority of injured children were Caucasian (94%), male (64%), and ≤ 5 years of age at the time of the incident (63%). Bystanders were 69% of those injured, 24% were lawn mower riders, and mower operators and others accounted for 7%. The lawn mower operator was usually male (77%), being the father/stepfather in almost half. Overall, 59% of injuries occurred while traveling in reverse, 29% while moving forward. Nearly all (92%) had an amputation and/or permanent disability. Subgroup analysis (n = 130) found injured bystanders were younger than injured passengers with 71% versus 45% being < 5 years of age, respectively ($P = 0.01$). Over three-quarters of bystander incidents occurred while moving in reverse as compared to 17% of passenger incidents ($P < 0.01$). Amputations and/or permanent disabilities were greater among bystanders (97%) as compared to passengers (79%, $P = 0.01$). Only 3% of bystanders had an upper extremity injury as compared to 21% of passengers ($P = 0.01$). Seventy-three percent of bystander victims had received at least one ride on a lawn mower prior to their injury incident.

Conclusions: Child bystanders seriously injured by riding lawn mowers were frequently given prior rides likely desensitizing them to their inherent dangers and leading them to seek rides when mowers were being used. Engineering changes preventing blade rotation when traveling in reverse and not giving children rides (both when and when not mowing) may be critical in preventing mower-related injuries.

Source: *Jennissen CA, Krupp TD, Vakkalanka JP, Hoogerwerf PJ. Pediatric lawn mower-related injuries and contributing factors for bystander injuries. Inj Epidemiol. 2023 Oct 20;10(Suppl 1):51. doi: 10.1186/s40621-023-00468-z. Use is per Creative Commons 4.0 International License.*

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Inventor's CORNER/How I Built That

By Joseph Hamad

From Frozen Kids' Treat to Inside-Cast Relief: The CastPack

In the words of Plato, "Necessity is the mother of invention". This is the story of the *CastPack*™, a novel and innovative cold therapy device designed to alleviate the suffering caused by the placement of casts.

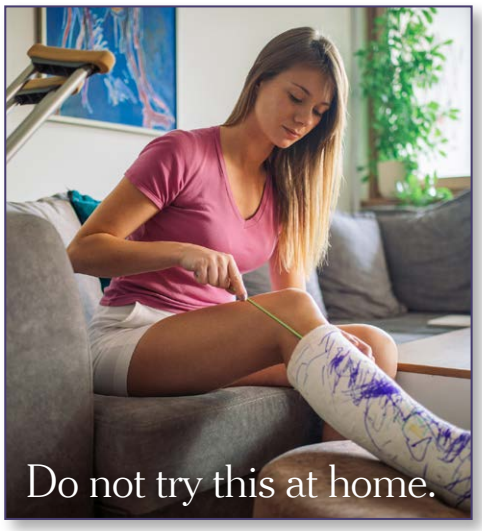
In 2020, like many middle-aged weekend warrior athletes, I jumped into a competitive pick-up game of basketball, without warming up or stretching. Then, as I lunged for a loose ball, POP! What felt like a baseball bat to the back of the leg was a fully ruptured Achilles tendon. A few days later I was a post-operative patient fit with a medical cast around my foot, ankle, and calf.

Soon after, as with virtually all casted patients, came the pain, the swelling, and the itching. To this day, patients are prescribed 2 options to relieve symptoms: pain relieving medications (typically narcotics) and cold therapy application to the cast exterior. The former may curb pain but come with well-known side effects and potential for addiction. The latter is simply ineffective, as the cast is too thick to allow for the cooling effects to reach the skin.

While in a cast and unwilling to take pain medications, I was desperate to find a solution mostly for the severe pain and itching. The proverbial light bulb went off when giving my 5-year-old daughter a frozen ice pop. Although I don't endorse this, I slid 3 ice pops down my cast and the rest was history. Gone was the itching. The pain and swelling reduced significantly. Medications went to the trash bin and the idea of the *CastPack* was born.

Simply put, it is a reuseable cold pack placed into a freezer and once frozen, inserted between the cast's inner lining and the skin. Suggested use is icing for 20 minutes every 2 hours. Doing so allows for the well-known benefits of cold therapy to be experienced by casted patients, directly to the affected body part. Patients who do not have normal skin sensation (eg, paraplegia, diabetes, or neuropathy) should check with their doctors before using.

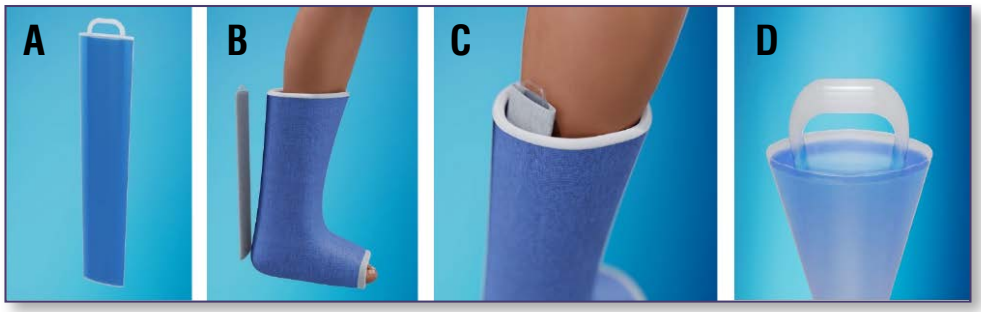
To avoid direct contact between the cold therapeutic device and the skin, a cloth sleeve is used as a barrier. The cloth sleeve also acts to absorb any small amount of moisture/condensation that can result and should be used every time. Once cold therapy is complete, the *CastPack* can



be safely removed by pulling out the cast using the looped end.

This simple yet elegant solution to a universal problem can not only provide safe and immediate relief from annoying symptoms, but also help reduce dependence upon and potential addiction to pharmacological treatment options.

CastPack is proud to announce it has been formally granted a US Patent. So, to achieve fast and wide market penetration, we are looking for manufacturing partner licensing agreements. Please contact me for more information.



a) CastPack. b) CastPack slides between the skin and the cast. c) Close-up shows cloth sleeve with CastPack in position. d) CastPack loop top enables easy removal from cast.

***Joseph Hamad** is a floor covering professional in central Pennsylvania. With more than 22 years in floor coverings, he has experience in retail, commercial, new home construction, and multi-family.*

*For more information about the product, visit **cast-pack.com.***

Inventor's Corner is an occasional feature that highlights the development of products relevant to LER readers. Our goal is to highlight the inherent creativity and perseverance of the inventors in their product development journey. To nominate a product for consideration, please complete the Inventor's Corner Nomination Form. Please note the views and opinions expressed here are solely those of the author and do not necessarily reflect the official policy or position of Lower Extremity Review.

Seeking the Optimal AFO Stiffness for Energy Cost Reduction

By NFJ Waterval, MSC; MM van der Krogt, Dr; K Veerkamp, T Geijtenbeek, PhD; J Harlaar, Dr, IR; F Nollet, MD, PhD; and MA Brehm, PhD

To maximize the AFO's effect on walking energy cost reduction, the AFO's bending stiffness needs to be individually optimized.

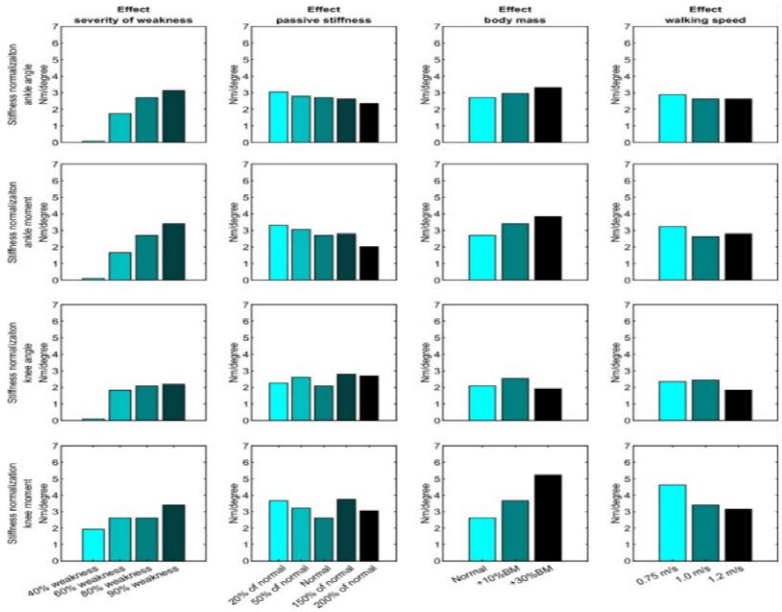


Figure 1. Effects of muscle pathophysiology, body mass, and walking speed on the minimum AFO stiffness necessary to normalize the ankle angle, ankle moment, knee angle and knee moment.i

The stiffness of a dorsal leaf ankle foot orthosis (AFO) that minimizes walking energy cost in people with plantarflexor weakness varies between individuals. Using predictive simulations, the authors of this article studied the effects of plantarflexor weakness, passive plantarflexor stiffness, body mass, and walking speed on the optimal AFO stiffness for energy cost reduction.

Methods

The study authors employed a planar, 9-degrees-of-freedom musculoskeletal model, in which for validation maximal strength of the plantarflexors was reduced by 80%. Walking simulations, driven by minimizing a comprehensive cost function of which energy cost was the main contributor, were generated using a reflex-based controller. Simulations of walking without and with an AFO with stiffnesses between 0.9 and 8.7 Nm/degree were generated. After validation against experimental data of 11 people with plantarflexor weakness using the Root-mean-square error (RMSE), the study authors systematically changed plantarflexor weakness (range: 40–90% weakness), passive plantarflexor stiffness (range: 20–200% of normal), body mass (+30%), and walking speed (range: 0.8–1.2 m/s) in their baseline model to evaluate their effect on the optimal AFO stiffness for energy cost minimization.

Results

The simulations had an RMSE < 2 for all lower limb joint kinetics and kinematics except the knee and hip power for walking without an AFO. When systematically varying model parameters, more severe plantarflexor weakness, lower passive plantarflexor stiffness, higher body mass, and walking speed increased the optimal AFO stiffness for energy cost minimization, with the largest effects for severity of plantarflexor weakness.

Discussion

The study authors showed a strong and interactive effect of severity of plantarflexor weakness and speed on the optimal AFO stiffness for walking energy cost reduction. Body mass and passive plantarflexor stiffness influenced the optimal stiffness to a less extent. Further, the optimal AFO stiffness for energy cost minimization was higher compared to the stiffnesses best normalizing specific gait parameters.

The simulations of walking without the AFO overestimated the effect of plantarflexor weakness regarding the maximal ankle dorsiflexion and external knee moment compared to experimental data, and were not as well predicted as with the AFO. This causes concern regarding the validity of walking energy cost and hence the effect sizes found by the different AFO stiffness levels. Further, the simulations without AFO demonstrated more dorsiflexion during stance and no foot drop during swing, compared to the experimental data. The exaggerated dorsiflex-

Continued on page 47

This article has been excerpted from "The interaction between muscle pathophysiology, body mass, walking speed and ankle foot orthosis stiffness on walking energy cost: a predictive simulation study." J NeuroEngineering Rehabil 20, 117 (2023). https://doi.org/10.1186/s12984-023-01239-z. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity.

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Continued from page 44

ion might be due to an underestimation of the passive ankle stiffness, as this was kept the same compared to the healthy model. The absence of a foot drop in the simulations is due to the fact that the study authors did not model dorsiflexor weakness to reduce the complexity of the simulations, while such weakness was present in the experimental population.

The study authors modeled the AFO as a massless rotational spring around the ankle, which has been proven valid in inverse dynamic simulations, but neglects the effects of AFO mass and of footplate stiffness on gait. They now demonstrated that such models are capable of predicting the effects of the AFO on lower leg kinematics and kinetics, although prediction of the ankle and hip power matched less well with experimental data. The simulations predicted a slight reduction in ankle power with an AFO instead of a slight increase. This may be explained by the lower predicted increase in walking speed with AFO in the simulations compared to the experimental data, and ankle power and AFO loading depend on walking speed.

Despite the discrepancies between the simulations and experimental data, in general the simulations did capture most important gait deviations caused by plantarflexor and effects of the AFO that influence walking energy cost. For most models, the optimal AFO stiffness reduces the walking energy cost with 0.8–1.2 J/kg/m compared to the no AFO simulations, which is similar to the effect of AFOs with an optimized stiffness found experimentally. This provides confidence that these simulations indeed provide an indication of the potential benefit of AFOs.

The simulations with different musculoskeletal models revealed that mainly severity of weakness, body mass, and walking speed explained the experimentally found variety in individual optimal AFO stiffness in individuals with plantarflexor weakness. In most cases, the optimal stiffness for energy cost minimization was between 3 and 5 Nm/degree with outliers as high as 7 Nm/degree for heavy models walking fast. That more severe weakness resulted in a higher optimal stiffness is in correspondence with data indicating that more affected patients put a larger strain on the AFO, and this larger strain likely also explains why walking faster results in a higher optimal stiffness. The fact that these inverted-pendulum simulations neglected the effect of speed on knee flexion in the loading response, and the corresponding higher plantarflexor activation in early stance, may be a reason for the discrepancy in results.

In case of plantarflexor weakness, the higher plantarflexor activation in the loading response is compensated for by the AFO, and hence more assistance is needed at higher speeds to minimize energy cost. Additionally, in this study, an interaction between the different factors studied seems to exist, as for example no effect of body mass on optimal stiffness was found when a higher, fixed walking speed was enforced. Without enforcing a higher walking speed, an increase in body mass resulted in a lower speed, which is more economic for obese people, which in turn reduced the optimal stiffness. Also, for passive stiffness an interaction with walking speed existed, as the effects of passive stiffness reduced when enforcing a faster speed. Contrary to the other models, for the model with 90% weakness the optimal stiffness increased at an enforced faster speed of 1.2 m/s. In this particular model, at low stiffness levels an external knee extension moment in the loading response was predicted, which may be favorable for energy cost, but will cause joint pain in humans. Additionally, the plantarflexors may be too weak to maintain a normal walking pattern at these faster speeds. Clinically, patients with severe bilateral plantarflexor weakness have a slower self-selected walking speed even with optimized AFOs.

All models using optimal AFO stiffness walked with a relatively similar ankle moment and knee moment. The stiffness necessary to normalize joint angles required less stiff AFOs compared to normalization of the joint moments or energy cost, especially for the knee (Fig. 1). Normalization of the knee moment might be more directly related with quadriceps activation, and hence energy cost, than knee angle. Additionally, to increase walking speed an increase in ankle moment is necessary, which apparently requires a higher stiffness compared to normalization of the ankle angle. However, the optimal AFO stiffness for energy cost minimization was consistently higher compared to the stiffness best normalizing both joint moments and angles, indicating that other factors also influence energy cost. Potentially, higher stiffness levels reduce energy cost further by taking over work of the plantarflexor muscles or by generating an external knee extension moment earlier in the gait cycle.

Conclusions

The forward simulations demonstrate that in individuals with bilateral plantarflexor weakness, the necessary AFO stiffness for walking energy cost minimization is largely affected by severity of plantarflexor weakness, while variation in walking speed, passive muscle stiffness, and body mass influence the optimal stiffness to a lesser extent. That gait deviations without an AFO are overestimated may have exaggerated the required support of the AFO to minimize walking energy cost. Future research should focus on improving predictive simulations in order to implement personalized predictions in usual care.

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Examining Effect of Tai Chi Lower Leg Exercise in Fall Prevention in Older Adults

By Min Mao, PhDc; Vicki S. Mercer, PT, PhD; Fuzhong Li, PhD; Michael T. Gross, PT, PhD, FAPTA; Troy Blackburn, PhD, ATC; and Bing Yu, PhD

Tai Chi is an evidence-based fall prevention training for older adults, yet its effective movements remain unclear.

Practicing Tai Chi (TC)—exercise that consists of a series of slow movements performed in semi-squat positions with an emphasis on coordination of whole-body movement and mind—is an effective way to prevent falls in older adults. Previous studies have demonstrated that practicing TC reduced risk of falls in older adults and improved clinical balance and walking measures. In addition, healthy community-dwelling older adults who practiced TC also had reduced center of pressure (COP) displacement and speed during bipedal and unipedal stance compared with older adults who exercised regularly but who did not practice TC. Although TC is an evidence-based fall prevention training for older adults, its effective movements remain unclear, which may limit the practice of TC. The purpose of this study was to compare the effectiveness of TC lower extremity exercise (TC LEE), the 8-form Tai Chi (8-form TC), and a stretching control intervention for improving balance and functional mobility among older adults.

Methods

A total of 102 participants (79 ± 6 years old) were recruited from assisted living facilities for this randomized controlled trial. All participants were randomly assigned to the TC LEE (n = 40), 8-form TC (n = 31), and stretching (n = 31) groups in which they received the respective interventions for 16 weeks. The Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and center of pressure (COP) measurements during quiet stance were collected prior to and following the 16-week interventions. Comparisons on all measurements were conducted among all groups.

TC LEE involved only the lower extremity movements of the 8-form TC, including: (A) Forward Stepping, (B) Backward Stepping, (C) Side Stepping, (D) Single-leg Stepping, (E) Turning Stepping, and (F) Fixing Stepping (Figure 1). The difficulty of the TC LEE movements increased gradually, requiring progressively greater postural control and coordination. The participants were required to perform the TC LEE with their hands together in front of their waists throughout the entire exercise.

The 8-form TC consists of 8 poses selected from the 24-form Tai Chi. The 8 forms were named as: (1) Commencing Form, (2) Repulse Monkey, (3) Grasp Peacock's Tail, (4) Wave Hands Like Clouds, (5) Fair Lady Works at Shuttles, (6) Golden Cock Stands on One Leg, (7) Brush Knees, and (8) Closing Form (Figure, page 33). Initial movements involved upper extremity movement patterns, such as Commencing Form, which required minimal postural

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This article has been excerpted from "The effect of Tai Chi lower extremity exercise on the balance control of older adults in assistant living communities. BMC Complement Med Ther. 2024;24(1):112. doi: 10.1186/s12906-024-04382-9. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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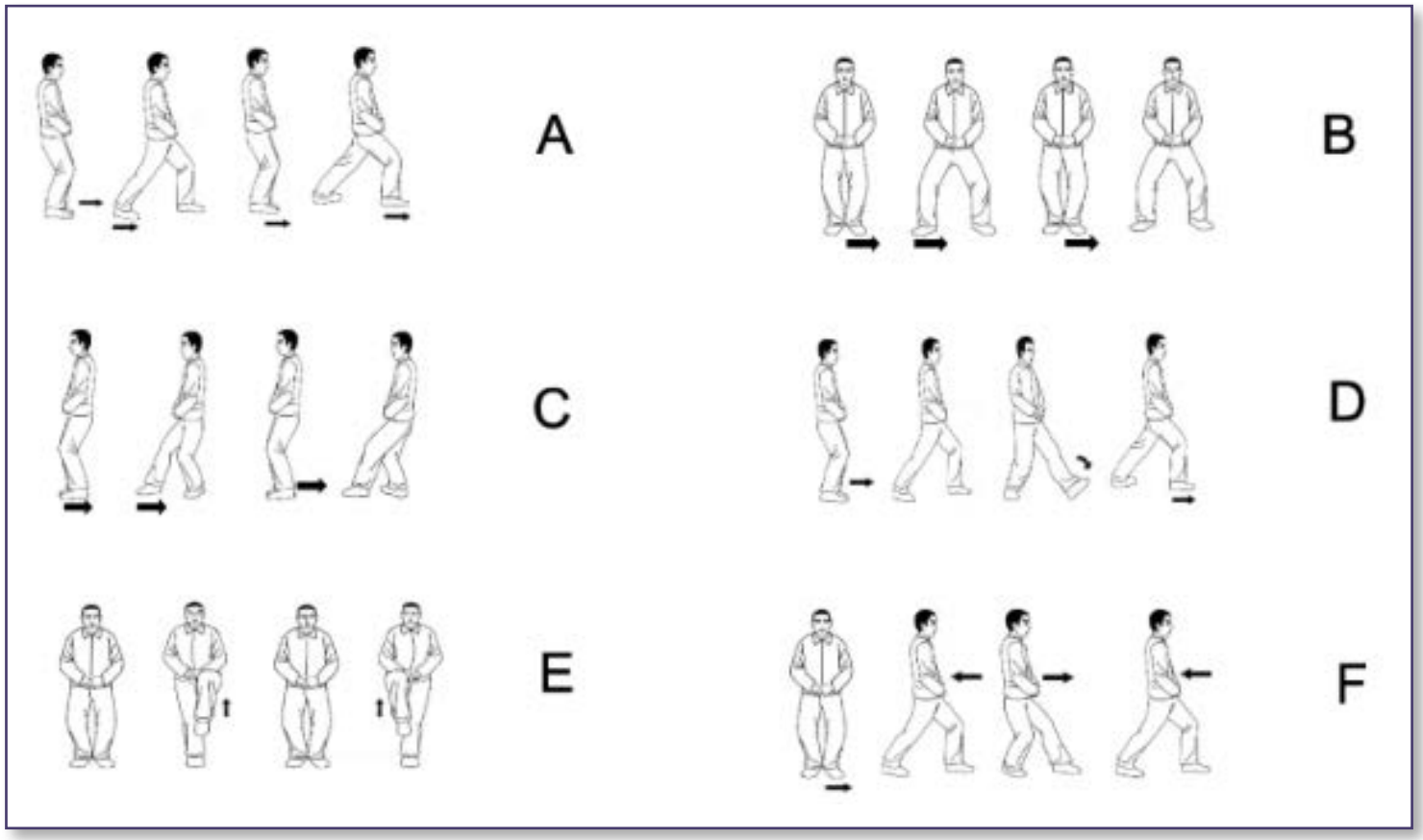

Figure 1. Tai Chi lower extremity exercise: A) Forward Stepping, B) Side Stepping, C) Backward Stepping, D) Turning Stepping, E) Single-leg Stepping, and F) Fixing Stepping.

control and whole-body coordination. The difficulty of the movements increased gradually and required more postural control and coordination of the entire body, such as Brush Knees. (See "Biomechanical Analysis of Thoracolumbar Rotation During Tai Chi Movements," page 33.)

The stretching intervention included light walking, stretching, and relaxing. Each session began with 15 minutes of light walking (60–65% of the maximal heart rate) followed by 30 minutes of stretching of the major muscle groups of the entire body. After the stretching, participants completed 15 minutes of relaxation with deep breathing and meditation.

Results

Significant improvements were found in BBS ($P = 0.002$), TUG test ($P = 0.001$), root mean square (RMS) amplitude of COP displacement in the anterior-posterior ($P = 0.001$) and medial-lateral ($P = 0.001$) directions, and average COP speed in the anterior-posterior ($P = 0.001$) and medial-lateral ($P = 0.001$) directions after training in the TC intervention groups compared with the stretching group. The upper limit of the 95% confidence interval (CI) of differences in change scores on the BBS (-0.8–1.3 points) between the TC LEE group and the 8-form TC group was within equivalence margins (1.8 points), while the upper limit of the 95% CI of differences in change scores on the TUG test (0.1–2.1 s) exceeded the equivalence margin (0.7 s) with the TC LEE group having the larger change scores.

No intervention safety issue was reported (falls, fractures, and joint pain etc. during or after training).

Discussion

The improvement on the BBS and TUG tests indicates improvements in balance and mobility in older adults. The average BBS scores in TC LEE and 8-form TC groups increased by 2.7 ± 2.3 points and 2.6 ± 2.2 points, respectively, indicating that increases in the BBS in the TC LEE and 8-form TC group after intervention might be marginally meaningful. The TUG test values in TC LEE and 8-form TC groups decreased by 3.2 ± 1.0 s and 2.1 ± 2.4 s, respectively, suggesting the improvements of TUG test after training in both TC groups were meaningful.

Significant reductions in the RMS amplitude of COP displacement and the speed of COP were found in both TC intervention groups compared with the control group after training in this study, which was consistent with previous findings. Collectively, these findings suggest that both of the TC interventions evaluated in this investigation may improve balance and functional mobility in older adults.

TC movements have characteristics that might promote improved balance in older adults, such as slow movements, frequent body weight shifts in various directions, large range of motion of lower extremity joints, and maintenance of a semi-squat position, which require precise neuromuscular control for coordination. Both the 8-form TC and the TC LEE forms include these beneficial characteristics. These

Continued on page 52

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characteristics could potentially challenge the balance control of older adults, thereby improving the control of body weight over the base of support and improving the neuromuscular control of the lower extremities. The body weight shifts in the forward, backward, lateral, and diagonal directions mimic movements in daily life for older adults, thus potentially transferring to improved dynamic balance during movement. The combination of these improvements may, therefore, decrease falls risk of older adults.

The results of this study suggest that TC LEE produces similar improvements in the BBS and greater effects on the TUG test compared with the 8-form TC form. One unique characteristic of TC LEE is that it is performed without upper extremity movements, which potentially makes TC LEE movements more challenging to maintain balance. Because upper extremity movements serve an important role in maintaining balance, without assistance from the upper extremities, practitioners might need greater momentum from the lower extremities in moving the trunk toward the direction of shifts in body weight and may need more precise neuromuscular control of their lower extremities to generate enough momentum for shifts in body weight, but not too much to cause a loss of balance. Consequently, the TC LEE might require more effort to maintain balance during training sessions. These findings might suggest that the lack of upper extremity movements in the TC LEE intervention might produce greater improvements in balance in older adults.

Because TC LEE is practiced without arm movements, it might require less cognitive resources, and it may be easier to learn for older TC beginners, frail older adults, older adults with decreased cognitive capabilities, and older adults with upper extremity injuries who would like to improve their balance and prevent falls. Practicing TC LEE could improve balance control and functional mobility, which can serve as a new option for clinicians to treat patients with increased risk of falls. Clinicians can teach patients the entire set of TC LEE movements, or they can select some of the stepping movements of interest for patients to practice. In addition, clinicians can combine TC LEE with existing fall prevention programs to provide effective, individualized, and multiple interventions for patients. Furthermore, TC LEE could be applied in different settings, such as, clinics, assisted living facilities, nursing homes, and communities.

Conclusion

In this study, the authors developed the TC LEE, which was performed with no upper extremity movements and with movement patterns that involved frequent shifts in body weight and frequent changes in stepping direction. TC LEE may simulate balance challenges encountered in daily activities by older adults. Based on the results of this study, TC LEE could be used as an effective balance training exercise for older adults and may have a greater effect than the 8-form TC on improving functional mobility as measured by the TUG test. ler

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BIOMECHANICAL ANALYSIS OF THORACOLUMBAR ROTATION DURING TAI CHI MOVEMENTS

The impact of spinal mobility and sagittal spinal shape on the development of balance impairment supports the hypothesis that enhancing spine flexibility results in an improvement in postural balance ability. Therefore, the aim of this study was to investigate whether the range of motion of thoracolumbar rotation during the movements of the Tai Chi Peking style routine is sufficient to improve thoracolumbar flexibility. Three-dimensional kinematic and kinetic data were collected from 8 athletes of the German Wushu Federation, while performing all movements of the entire Peking style routine (1) in a competition version corresponding to national/international championships and (2) in a health sport version performed with shorter and higher stances (i.e. a smaller distance between the feet and thus less knee flexion). For each movement the total mean and standard deviation values for the total range of motion of thoracolumbar rotation was calculated. Statistical analysis was performed using the Wilcoxon signed-rank test for paired differences. Eight movements showed major differences (10.12–19.73◦) between the two versions. For the remaining movements, only minor differences (0.7–9.56◦) were observed. All movements performed on both sides showed no significant lateral differences. Most of the Tai Chi movements, regardless of the performed version, cover a range of motion of thoracolumbar rotation that has the potential to lead to an improvement of thoracolumbal spine flexibility with appropriate training. The most effective single movements (25.97–72.22◦) are *Brush Knee and Step Forward, Step Back and Repulse Monkey, Grasp the Sparrow's Tail, Wave Hand in the Clouds,* and *Fair Lady Weaves with Shuttle.*

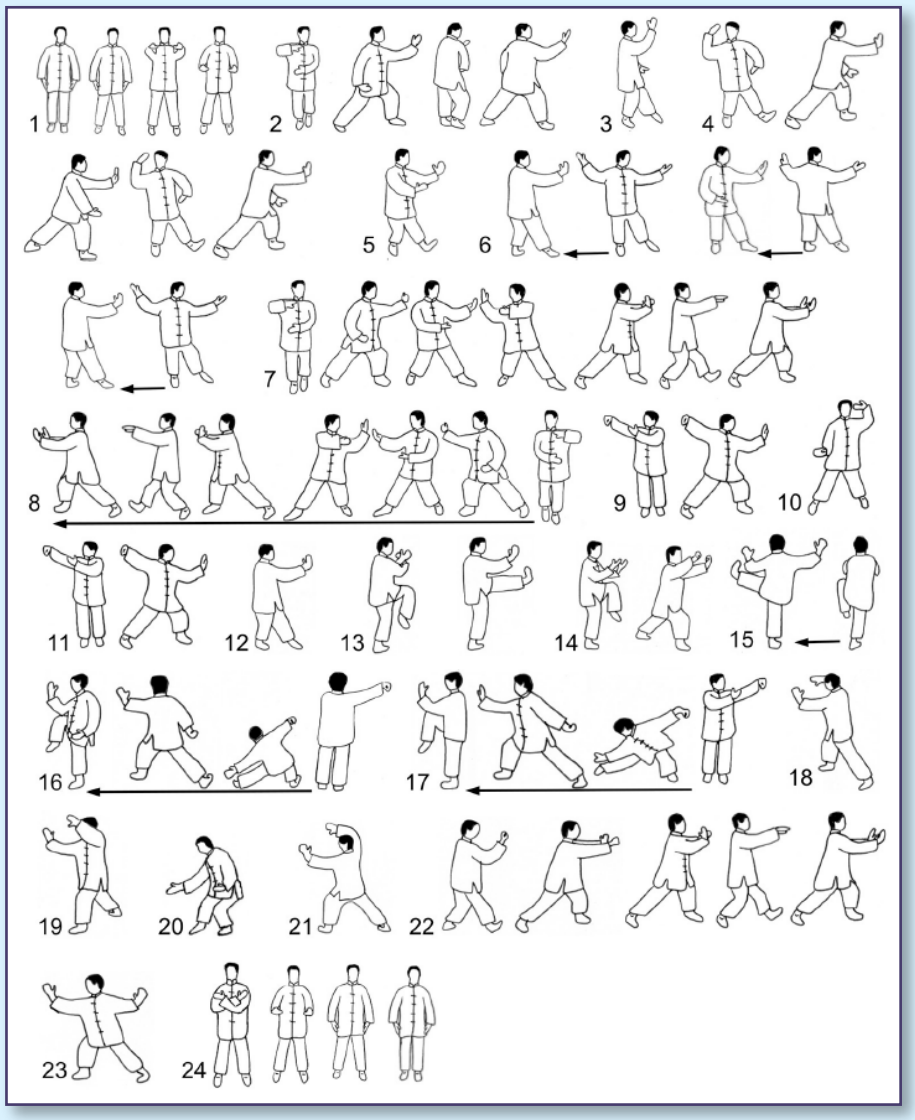

Figure. Movements of the Peking style routine. 1) Beginning; 2) Part the wild horse's mane (left and right); 3) White crane spreads its wings; 4) Brush knee and step forward (left and right); 5) Playing the lute; 6) Step back and repulse monkey (left and right); 7) Grasp the sparrow's tail (left); 8) Grasp the sparrow's tail (right); 9) Single whip; 10) Wave hand in the clouds; 11) Single whip; 12) High pat on horse; 13) Right heel kick; 14) Strike to ears with both fists; 15) Left heel kick; 16) Lower body and stand on one leg (left); 17) Lower body and stand on one leg (right); 18) Fair lady weaves with shuttle (right and left); 19) Pick up the needle from the sea bottom; 20) Fan back; 21) Turn body, Deflect, Parry, and Punch; 22) Seal tightly; 23) Cross hands; and 24) Closing. Highlights indicate the most effective movements; these 5 are also included in the TC-8 form in the accompanying article by Mao et al.

Source: *Wehner C, Wehner C, Schwameder H, Schobersberger W. Thoracolumbar rotation during Tai Chi movements—a biomechanical analysis of the entire Peking Style routine. Front. Sports Act. Living. 2022;4:834355. doi: 10.3389/fspor.2022.834355. Use is per CC Attribution 4.0 International License.*

New & Noteworthy

Noteworthy products, association news, and market updates

REVERE EMBARKS ON NEW GROWTH CHAPTER

Orthotic-friendly footwear brand, Revere, Palm Beach Gardens, Florida, announced a significant step in its growth journey through a new partnership with footwear accessory brand veteran, Josh Higgins. Alongside his new capacity with Revere, Higgins will remain dedicated to his primary role as president of performance OS1st, Hickory, North Carolina, a brand in performance socks and compression bracing.

In addition to becoming a part owner, Higgins, through his company Higgins Sales Group, will provide strategic guidance to Revere, drawing upon his extensive experience in product development, sales, and brand growth within the independent retail channel.

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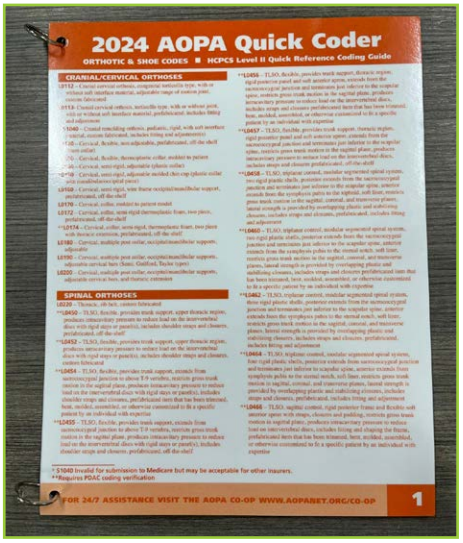

The 2024 American Orthotic and Prosthetic Association (AOPA) Quick Coder is now available. This redesigned, speedy reference to the Healthcare Common Procedure Coding System (HCPCS) codes for all orthotic, shoe, and prosthetic codes and modifiers also provides references for inpatient billing and off-the-shelf versus custom-fit coding. These laminated cards are durable, long-lasting, and convenient to store. Changes are now being made to codes on a biannual basis. If a change is made during the year, AOPA will send out notifications. This will ensure the Quick Coder remains up-to-date throughout the year.

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KOREAN RESEARCHERS DEVELOP WEARABLE MOBILITY AID

Dr. Lee Jongwon of the Intelligent Robotics Research Center at the Korea Institute of Science and Technology (KIST) has developed a wearable robot, MOONWALK-Omni, which means "to actively support leg strength in any direction (omni-direction) to help walk like walking on the moon." Further, he has announced that a senior citizen wearing it successfully completed a wearable robot challenge to climb to the top of Mount Yeongbong (604 meters above sea level) in Korea.

MOONWALK-Omni is an ultra-light weight wearable strength-assistance robot that predicts the user's movements and supports insufficient leg strength to help the elderly rehabilitate and assist with daily activities. The 2-kilogram device can be easily donned by an older adult in less than 10 seconds without assistance, and its 4 high-powered actuators on either side of the pelvis help balance the user while walking and boost the wearer's leg strength by up to 30% to increase propulsion.

An elderly man walks up a complex stone staircase environment while wearing the robot during a wearable challenge in Korea. Image courtesy of KIST.

The robot's artificial intelligence analyzes the wearer's gait in real time and provides safe and effective muscle support in a variety of walking environments, including gentle slopes, rough rocky paths, steep wooden stairs, and uneven stone steps. Through the Bukhansan Mountain Wearable Robot Challenge, the research team succeeded in verifying the performance and reliability of muscle support using

wearable robots in everyday environments that are more complex than hospitals.

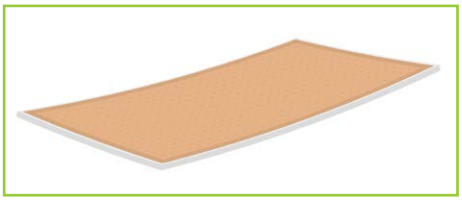
As a follow-up to this innovation, the research team is developing MOONWALK-Support, which not only strengthens leg muscles but also supports the complex joints of the lower extremities such as the hip and knee.

FOLDING TRAVEL POLES

The Motivator Folding Travel Pole combines the innovative, patented ergonomic Motivator grip with the York Nordic's renowned travel poles to ensure the ability to continue rehabilitation and walking routines while traveling or on the move. The Motivator Folding Travel Pole has been lauded by physical therapists for its use in the rehabilitation process due to the increased balance and stability patients find with the unique grip offering 2 thumb positions. The strapless grip design improves proprioception and offers state-of-the-art ergonomics and hand support for the biaxial saddle joint. The result is a 10 times reduction in stress at the carpometacarpal joint minimizing torsional load while providing balance and stability to the patient looking for motivation to begin walking more confidently. The travel poles fold up to 13.5", so that they can easily be packed or stored during travel.

York Nordic
800/930-5928
yorknordic.com

SECONDARY DRESSING FOR MALODOROUS WOUNDS



In addition to causing pain, swelling, and itching, leg ulcers can also cause a foul-smelling discharge. That's where Cinesteam can make a difference. While there are other options to address wound malodor, the unique advantage of Cinesteam is that it is fast-acting. It is a secondary dressing—ie, it must be placed on top of the primary dressing and doesn't come in contact with the wound itself. This directly treats the underlying cause of wound odor by adsorbing the smells before they can spread out to the rest of the room and invade others' olfactory senses. Each dressing contains a sealed sachet filled with the key ingredient of cinnamon powder. This is situated on top of an absorbent core, providing an additional layer of odor protection that can make it easier for those managing leg ulcers to remain comfortable.

Cinesteam
contact@cinesteamcare.com
cinesteamcare.com

NEW MODEL PREDICTS HOW SHOE PROPERTIES AFFECT A RUNNER'S PERFORMANCE

Engineers at the Massachusetts Institute of Technology have developed a new model that predicts how certain shoe properties will affect a runner's performance. The model represents a runner as a center of mass, with a hip that can rotate and a leg that can stretch. The leg is connected to a box-like shoe, with springiness and shock absorption that can be tuned, both vertically and horizontally. The simple model incorporates a person's height, weight, and other general dimensions, along with shoe properties such as stiffness and springiness along the midsole. With this input, the model then simulates a person's running gait in a particular shoe. This allows researchers to simulate how a runner's gait changes with different shoe types. They can then pick out the shoe that produces the best performance, which they define as the degree to which a runner's expended energy is minimized.

Researchers measure the stiffness of midsole designs using an Instron machine to mimic footsteps. Image courtesy of MIT.

As part of their work, the team sought to identify a biological cost function that is general to most runners, which could then allow them to predict not only a person's gait for a given shoe but also which shoe produces the gait corresponding to the best running performance. They found that most runners tend to minimize 2 costs: the impact their feet make with the treadmill and the amount of energy their legs expend. As a final step, the researchers simulated a wide range of shoe styles and used the model to predict a runner's gait and how efficient each gait would be for a given type of shoe.

While the model can accurately simulate changes in a runner's gait when comparing 2 very different shoe types, it is less discerning when comparing relatively similar designs. Thus, the researchers envision the current model would be best used as a tool for shoe designers. However, the team is planning to improve the model, in hope that consumers can someday use a similar version to pick shoes that fit their personal running style.

REALTIME FEEDBACK ON WALKING QUALITY, QUANTITY

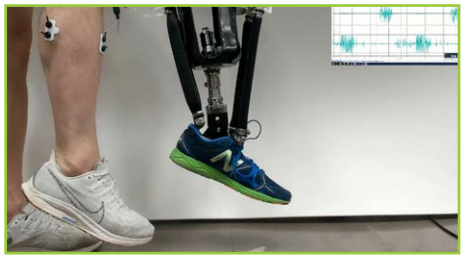
For gait analysis in real-time, the EVOLVE MVMT wearable device focuses on the heel strike and quality of each step, versus quantity of steps taken. It enables users to enhance their walking technique by improving muscle recruitment to achieve health benefits like burning more calories when walking the same distance and minimizing force transmitted through the joints. Created with over 15 years of research and development, the wearable guides users to improve the quality of each step through applied correction and the technique of "light walking"; this technique has several other key lifestyle benefits like improved posture and injury prevention. Users start the EVOLVE MVMT journey with a short walking test to understand and identify their own walking pattern. Users will then receive individualized guidance on improving their score through daily or weekly walks, all which can be customized, viewed, and tracked within the accompanying app, based on unique health goals.

EVOLVE MVMT
evolvemvmt.com

ROBOTIC PROSTHETIC ANKLES IMPROVE MOVEMENT, STABILITY

Robotic prosthetic ankles that are controlled by nerve impulses allow individuals with lower limb amputations to move more "naturally," improving their stability, according to researchers from North Carolina State University (NC State) and the University of North Carolina (UNC) at Chapel Hill. "This work focused on 'postural control,' which is surprisingly complicated," said Helen Huang, PhD, the Jackson Family Distinguished Professor in the Joint Department of Biomedical Engineering at NC State and UNC.

This study builds on previous work, which demonstrated that neural control of a powered prosthetic ankle can restore a range of abilities, including standing on challenging surfaces and squatting. The researchers worked with 5 people who had unilateral transtibial amputations. Study participants were fitted with a prototype robotic prosthetic ankle that responds to EMG signals that are picked up by sensors on the leg. The researchers conducted general training for study participants using the prototype device, so that they were somewhat familiar with the technology.



EMG sensors (on calf at left) capture electrical activity generated by muscles when they are flexed. This signal tells the prosthesis which artificial muscle to flex and how much to flex. For individuals with amputation, these sensors are placed in the prosthetic socket. The graph (right) shows the EMG signal, which is used to control the prosthesis. Image courtesy of Aaron Fleming.

Study participants were then tasked with responding to an expected perturbation under 2 conditions: using the prostheses they normally used, and using the robotic prosthetic prototype.

"We found that study participants were significantly more stable when using the robotic prototype," said Aaron Fleming, a recent PhD graduate from NC State. "They were less likely to stumble or fall."

In a separate portion of the study, researchers asked study participants to sway back and forth while using their normal prostheses and while using the prototype robotic prosthesis. Study participants were equipped with sensors designed to measure muscle activity across the entire lower body.

"Basically, muscle activation patterns when using the prototype prosthetic were very similar to the patterns we see in people who have full use of 2 intact lower limbs," said Huang. "That tells us that the prototype we developed mimics the body's behavior closely enough to allow people's 'normal' neural patterns to return."

ROBOTIC WEARABLE IMPROVES WALKING FOR PD PATIENT

A team of researchers from the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Boston University Sargent College of Health & Rehabilitation Sciences have used a soft, wearable robot to help a person living with Parkinson's disease (PD) walk without freezing. The robotic garment, worn around the hips and thighs, gives a gentle push to the hips as the leg swings, helping the patient achieve a longer stride. The device completely eliminated the participant's freezing while walking indoors, allowing them to walk faster and further than they could without the garment's help.

The robotic garment, worn around the hips and thighs, gives a gentle push to the hips as the leg swings, helping the patient achieve a longer stride.

"We found that just a small amount of mechanical assistance from our soft robotic apparel delivered instantaneous effects and consistently improved walking across a range of conditions for the individual in our study," said Conor Walsh, PhD, the Paul A. Maeder Professor of Engineering and Applied Sciences at SEAS.

The team spent 6 months working with a 73-year-old man with PD, who—despite using both surgical and pharmacologic treatments—endured substantial and incapacitating freezing episodes more than 10 times a day, causing him to fall frequently. These episodes prevented him from walking around his community and forced him to rely on a scooter to get around outside.

In previous research, Walsh and his team leveraged human-in-the-loop optimization to demonstrate that a soft, wearable device could be used to augment hip flexion and assist in swinging the leg forward to provide an efficient approach to reduce energy expenditure during walking in healthy individuals. Here, the researchers used the same approach but to address freezing. The wearable device uses cable-driven actuators and sensors worn around the waist and thighs. Using motion data collected by the sensors, algorithms estimate the phase of the gait and generate assistive forces in tandem with muscle movement. The effect was instantaneous. Without any special training, the patient was able to walk without any freezing indoors and with only occasional episodes outdoors. He was also able to walk and talk without freezing, a rarity without the device.

The device could also be used to better understand the mechanisms of gait freezing, which is poorly understood.

REFLECTIVE KINESIOLOGY TAPE

RockFlash Reflective Kinesiology Tape is a pre-cut, easy-to-apply tape that may help reduce joint discomfort and expedite recovery. Unlike standard kinesiology tape, RockFlash is made

from reflective materials that reflect light from any source, such as headlights, flashlights, or streetlamps. The product is ideal for people who are active in low-light conditions, like early-morning or evening runners, cyclists, walkers, or outdoor enthusiasts. RockFlash can be applied to various parts of the body for optimal movement. This latex- and zinc-free, ultra-strong, and sticky adhesive is water resistant and will stick for up to 2–7 days. It offers 180% stretch for full range of motion. Pre-cut strips make for easy self-application.

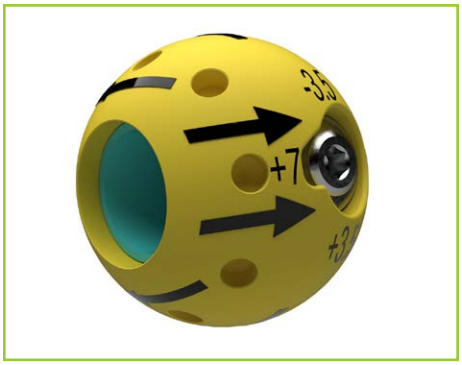
RockTape
rocktape.com

PORTABLE ULTRASOUND DEVICE

Pure Skincare Co.'s recently launched ultrasound therapy device offers a variety of health benefits, as it may accelerate recovery following an injury, minimize cellulite and scar tissue, and ease post-workout body aches. The device uses ultrasound waves at a frequency of 1Mhz to penetrate up to 8mm into bodily tissues. The continuous sounds waves emitted from the machine stimulate vasodilation, allowing for better blood flow and circulation in the targeted area, which relaxes muscles. People who may benefit from the use of the device include those who suffer from chronic conditions like arthritis, sciatica, fibromyalgia, and joint aches, as well as individuals who sit or stand for long periods of time. It may also help improve quality of sleep and help reduce stress and anxiety, as it promotes a sense of physical relaxation and loosens tight muscles. Each device comes with a power adaptor and user manual.

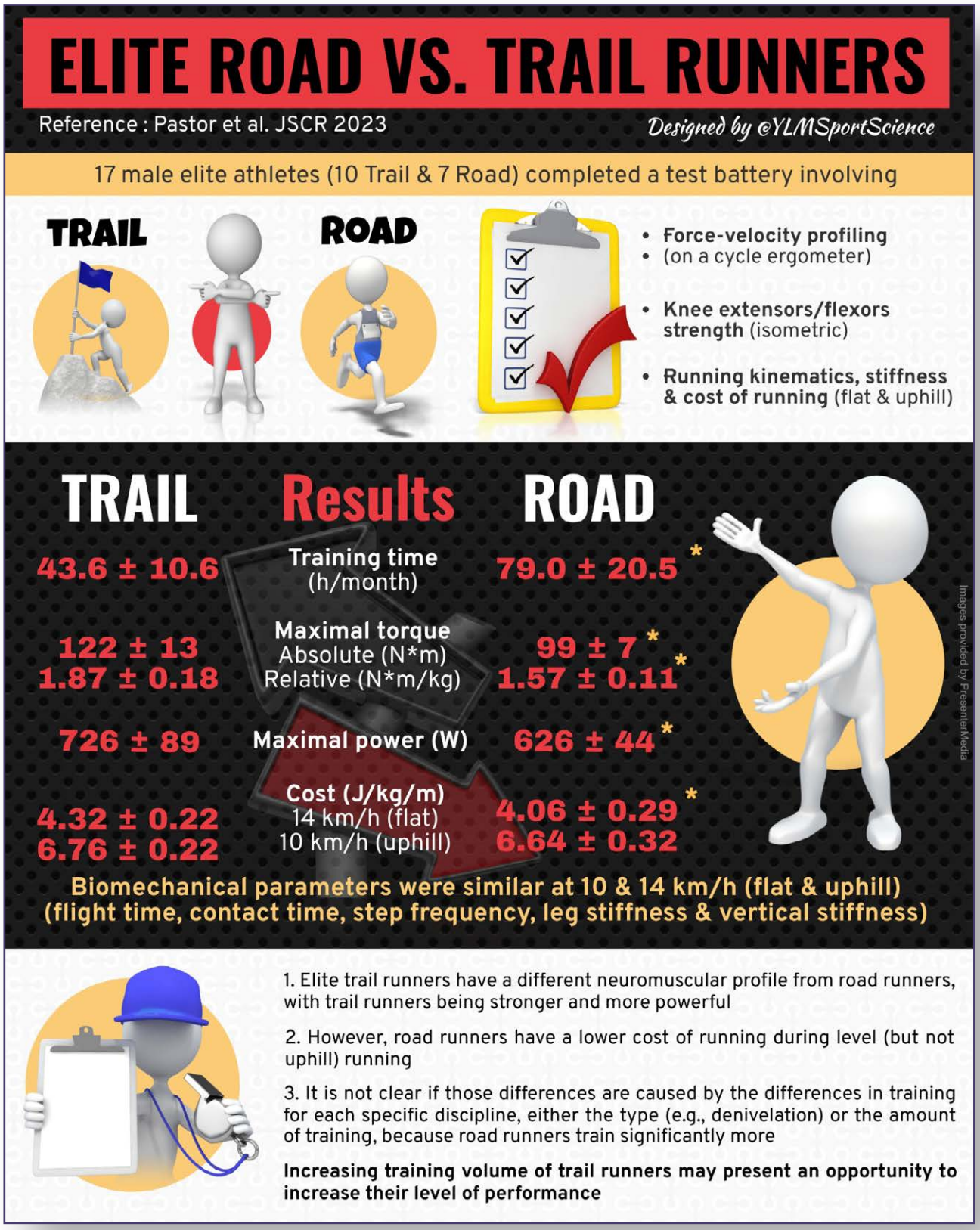
Pure Skincare Co.
800/881-5993
pureskincareco.com

TENSIONING INSTRUMENT FOR HIP REPLACEMENTS



The HIPTURN™ (Tension Under ReductioN) device gives surgeons the ability to trial different offset and neck options accurately and efficiently without removing any constructs. The device seamlessly integrates into the company's robust hip product line and works alongside the Profemur® line of hip stems, the Dynasty® & Prime™ line of acetabular cups, and in conjunction with the SuperPath® and AnteriorPath™ surgical techniques. The HIPTURN™ tensioning instrument saves time and causes less tissue trauma. This device not only makes the surgeon experience better, but it also provides faster, more efficient data, which ultimately encourages better safety for the patient.

MicroPort Orthopedics
866/872-0211
microportortho.com



Source: Sabater Pastor F, Besson T, Berthet M, et al. Elite road vs. trail runners: comparing economy, biomechanics, strength, and power. J Strength Cond Res. 2023;37(1):181-186. doi: 10.1519/JSC.0000000000004226.

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