Lower Extremity Review

ler:PEDIATRICS

February 2017

Flatfoot questions: Risk factors and assessment

Early athletic specialization: Misconceptions and hazards

PLUS:

- Energy costs of footwear, bare feet
- Brace wear time in clubfoot
- Lower extremity risk in martial arts

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features

From the editor:
Sports in the tiger-parenting era

It doesn't surprise me that focusing on achievement in a single sport at a young age substantially raises the risk of overuse injuries and can lead to other physical and developmental issues.

But experts quoted in our current feature (See "Early athletic specialization: Misconceptions and hazards," page 15) brought up some less intuitive points about the increasingly common practice of intense concentration on a single sport at a young age.

Many children who specialize are trading the slim hope of elite achievement—and often, parents are the driving force behind these hopes—for the benefits and pleasures of the noncompetitive play that used to characterize childhood. Not only did such varied play promote the fundamental mastery of many motor skills, playing different sports allowed children to find their athletic niche naturally, rather than be routed onto a narrow path.

Greg Myer, PhD, associate professor of pediatrics and director of research and the Human Performance Laboratory in the Division of Sports Medicine at Cincinnati Children's Hospital Medical Center in Ohio, said his biggest concern about early specialization is that it probably means many kids aren't playing the sport for which they're best suited.

Lower extremity practitioners can help their young patients by schooling parents on the facts, both obvious and subtle, starting with the data showing specialization can expose children to significant risks for injury now and in the future, and to issues ranging from emotional burnout to eating disorders.

And, in an era of tiger moms and dads, reminding parents, as does a longtime coach and athletic director in our feature, that despite the elusive allure of college scholarships and elite-athlete status, fun and a love of the game are perhaps better—and certainly less risky—reasons to play.

Emily Delzell, *Senior Editor*

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Shoes add to energy cost of gait compared with barefoot walking

Footwear should allow dynamic activity

By Greg Gargiulo

A recent study of the metabolic costs of barefoot versus shod walking found walking in shoes required a higher energy expenditure and had a poorer economy than barefoot walking. These outcomes suggest going barefoot may be preferable for children whenever it is deemed safe and appropriate, and highlights the need for practitioners to recommend properly fitted shoes designed for dynamic activity to minimize any negative impact on foot development.

"Previous adult data has shown a similar result, but our study does seem to solidify the sports science findings that shoes change our walking dynamic, which alters economy," said lead author Sarah Shultz, PhD, a senior lecturer in the School of Sport and Exercise at Massey University in Wellington, New Zealand.

For example, a 2011 study published in *Gait & Posture* found walking in industry-recommended athletic footwear was associated with increases in knee and hip net joint moments compared to barefoot walking, including a 9.7% increase in the first peak knee varus moment.

The 25 healthy participants (aged 8-12 years, 14 girls) completed two five-minute trials on a treadmill at a self-selected speed (1 ± .13 m/s), doing one trial barefoot and the other shod in a standardized lace-up athletic shoe with an elevated heel, rounded toe, arch support, and stiff midsole (total weight, 248 g ± 28 g).

Investigators sampled force plate data in each trial in 20-second intervals (120, 180, and 240 seconds) and used data collected at the 240-second time point to calculate vertical center of mass displacement (vCoM). They used a portable gas analyzer to collect expired gases and measure oxygen consumption and then calculated energy expenditure, walking economy, and substrate utilization.

The children's oxygen consumption and energy expenditure were significantly higher and economy significantly decreased while wearing shoes compared with barefoot walking. Barefoot walking also elicited significantly less vCoM than the shod condition. Children weren't given time to get used to the study shoes, but Schultz said all were familiar with the shoe type and had time to accommodate to walking on the treadmill.

Researchers proposed several factors potentially responsible for shod walking's poorer economy. The footwear's added mass may have increased energy costs during gait. A 2015 study by Shultz and colleagues evaluated a subset of the current cohort and found an increased stride length in the shod condition (1.03 ± .14 m) versus the barefoot condition (1 ± .13 m). These longer stride lengths could have had a similar effect to the added mass and changed vCoM, both of which are believed to increase the metabolic cost of walking.

> Shod gait recruits more hip muscles while barefoot walking depends more on the ankle and greater plantar flexor energy.

Data from the 2015 subset study also suggested the two modes of walking require unique mechanical demands, with shod walking recruiting more hip musculature, and barefoot depending more on the ankle and generating greater plantar flexor energy. These specific features may have also led to differences in elastic energy storage and affected overall walking economy.

"I do not think that any one factor is more significant than another [in contributing to poorer economy], mainly because there are multiple and overlapping relationships between them," Shultz said. "For instance, you cannot discriminate between effects on walking economy as a result of changes in stride length and changes in vCoM because there is an existing relationship between stride length and vCoM."

The *International Journal of Sports Medicine* published the study in May 2016.

"This study nicely complements the existing literature that shod and barefoot gait are significantly different and that footwear has a substantial impact on the kinematics, kinetics, and physiology of children's gait," said Caleb Wegener, PhD, the footwear research and innovation developer for Sydney, Australia-based Mack Boots and honorary research associate at the University of Sydney.


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Consequently, the decreased energy cost of barefoot walking found here should further guide clinicians' footwear recommendations for children.

"Although we didn't measure shoe fit in this study, properly fitted shoes that minimize any negative impact on foot development are very important, and I recommend allowing kids to go barefoot whenever it is safe and appropriate—most likely around the home—to help strengthen the foot and promote positive development. Playing sports will probably require shoes," Shultz said.

Wegener also noted why children's habitual behaviors need to be considered.

"Since the clinical effect required is to minimize the biomechanical and physiological effect of footwear, very flexible shoes are required," he said. "Clinically, I have tended to recommend the requirements for the foot, and then the activity, and the nature of children's play throughout the day means that all footwear worn by children should be designed for dynamic activity."

Still, Shultz believes future research will help to explore the specific factors at play in this study.

"Since this is a descriptive study and can only suggest possible reasons, further investigations using more of an intervention approach could help to determine the importance of any one factor that we identified," she said. ler

Greg Gargiulo is a freelance medical writer based in San Francisco.

Source:

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Sensor data quantify clubfoot patients' reported, real brace use

Parents overestimate wear times

By Peaches Yeilding

Researchers who used temperature-sensitive devices to measure brace-use adherence in children with clubfoot found parents overestimate brace wear time when reporting to clinicians and that children are not in their braces as long as their doctors recommend.

"We found a significant difference between reported and actual brace usage," said lead study author Lewis E. Zionts, MD, an orthopedic surgeon at the Orthopaedic Institute for Children in Los Angeles. Brace use recorded by sensors was 62% of that recommended by physicians and 77% of what parents reported. His group's findings were published in October in the *Journal of Bone and Joint Surgery*.

The Ponseti method—the gold standard for treatment of clubfoot—has a high success rate when patients comply with postcorrective brace protocols, and relapse of deformity is mostly attributed to noncompliance (See "Keeping kids in braces can prevent clubfoot relapse," February 2016, page 15). "Following doctor-recommended brace use is far and away the most important way to prevent relapse," Zionts said.

"An objective measurement is important because the time children actually are in the brace is unknown. We know parents overestimate, but not how much," said Jose A. Morcuende, MD, PhD, a pediatric orthopedic surgeon at the University of Iowa Hospitals and Clinics in Iowa City who was not involved in the study.

Study participants wore Mitchell-Ponseti braces, which Zionts and his colleagues customized by stapling a button-sized wireless temperature data logger in the sandal and drilling a hole in the back of the rubber liner so the sensor could detect body temperature. The sensors featured programmable data acquisition and a storage capacity of 2.048 readings, enough for continuous sampling every 90 minutes for four months. Both heels had a sensor, and sampling was offset so data were collected every 45 minutes.

Study authors recruited 48 participants who had completed the first three months of full-time brace use, with 12 patients enrolled in four age-based groups: six to 12 months, 13 to 24 months, 25 to 36 months, and 37 to 48 months. They instructed parents to use the brace 16 hours a day until their child was a year old, 14 hours per day for children aged between 12 and 24 months, 12 hours a day for those aged between 24 and 36 months, and 10 hours a day for individuals aged between 36 and 48 months. Forty-four participants completed the study.

> Data suggest eight hours or more of daily brace use helps prevent relapse, and that five hours is not enough.

Parents were instructed to use braces for a mean of 12.6 hours a day, but sensor data indicated actual usage was eight hours per day (median). For all participants, adherence ranged from 5% to 125%. Parents' reports were inflated, averaging 11.3 hours of daily brace use; the accuracy of those reports was 77%.

Eight of the 44 demonstrated relapse; brace application for those patients averaged five hours a day, and their mean adherence was 40%, compared with 64% for those who did not relapse.

Zionts's data suggest that, on average, eight hours or more of daily brace use helps prevent relapse, and five hours is not enough. "This information is good to have," said Morcuende, "but we can't draw major conclusions because the sample size was small."

Zionts agreed a larger cohort is needed to answer the question of how many hours braces must be worn to prevent relapse.

The circular outline of the temperature sensor used to collect data is visible in this Mitchell-Ponseti brace sandal. (Photo courtesy of Lewis E. Zionts, MD.)

Morcuende pointed out that the study population was not representative of the general population; 57% of participants made less than $20,000 a year and another 35% made between $20,000 and $39,999. In addition, 51% of parents were unmarried, and 39% had a high school education or less.

"Data have been mixed in previous studies," said Zionts. "Some earlier research has found socioeconomic factors, such as low education levels and single-parent status, can reduce parental compliance." In a 2010 review, Zionts and colleagues found giving parents written instructions tailored to their education level, as well as explanatory videos to take home, may help improve adherence.

"The key finding is children are not in the braces as long as their doctors recommend, and this is a nice study with objective measurements," Morcuende said.

"Our findings are a good starting point to develop braces with embedded sensors so that objective, accurate measurements of brace use routinely can be obtained and help identify which patients are receiving inadequate time in their brace. These patients can be targeted for more effective counseling," said Zionts.

Peaches Yeilding is a freelance writer in Washington, DC.

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Martial arts students at risk for lower extremity injury, sequelae

Traumas increase with age, skill level

By Chris Klingenberg

Martial arts participation has numerous benefits for children and adolescents, but it also has its risks—including lower extremity injury, according to a recent clinical report and literature review published by the American Academy of Pediatrics' (AAP) Council on Sports Medicine and Fitness.

The authors noted lower extremity injuries have been associated with karate and taekwondo. Both martial arts emphasize kicking, and lower extremity injuries can result from kicking, or being kicked.

Because most research on martial arts and injury risk has been done in adults, the AAP council issued the clinical report to help pediatric clinicians generalize findings to their younger patients. It was published in the December issue of *Pediatrics*.

"Children and adolescents should only participate in martial arts classes or competitions supervised by instructors with appropriate training regarding proper teaching of the particular activity and understanding of a child's limitations based on age, maturity, stature, and experience," said Rebecca Demorest, MD, a pediatric and young adult sports medicine physician with Webster Orthopedics in Oakland, CA, and first author of the clinical report. "Martial arts competition and contact-based training should be delayed until children and adolescents have demonstrated adequate physical and emotional maturity during noncontact preparation and competency with noncontact forms, movements, and techniques."

In a 2007 study, an estimated 128,400 children aged 17 years or younger (mean age, 12.1 years; 73% male) were treated in US emergency departments for martial arts-related injuries between 1990 and 2003, with most injuries (79.5%) attributable to karate.

On the plus side, martial arts injuries are generally not life-threatening, as the most common injuries include abrasions, contusions, sprains, and strains. Also encouraging is that younger martial arts participants seem to have a lower risk of injury than their older, more experienced counterparts, according to studies cited in the AAP report, though the authors wrote that more research on relationships between skill level, age, and injury risk is needed.

A 2005 study spanning five martial arts disciplines (Shotokan karate, Aikido, taekwondo, kung fu, and tai chi) found people aged 18 years or older were four times more likely to sustain an injury than those younger than 18 years; competitors with at least three years of experience were two times more likely to sustain injury than less experienced competitors. Participants younger than 18 years doubled their risk of injury with every two additional hours of training per week after the first three hours, and those training for more than three hours per week had an overall increased injury risk.

A 2013 study of Australian amateur taekwondo athletes found those younger than 10 years had an overall lower injury rate per 1000 athletic exposures compared with all other age groups; however, when adjusting for exposure time, the 10- to 14-year-old age group had a higher injury risk per minute of exposure compared with the open division.

Although lower extremity martial arts injuries in children may seem minor, not taking them seriously can have negative consequences for both health and performance, said Chris Koutures, MD, a pediatric and sports medicine specialist in private practice in Anaheim Hills, CA, and a coauthor of the AAP clinical report.

> Instructors need to understand a kid's age-, maturity-, stature-, and experience-based limits.
> —Rebecca Demorest, MD

"Coming back to martial arts too soon after a lower extremity injury can prolong pain, limit full participation, and potentially increase the risks of a more serious injury or a new injury, especially if the athlete is trying to protect the injured body part," Koutures said. "I have seen martial arts athletes plateau or even regress in the progression towards high belts and competitive success due to unresolved injuries. I also can see where, for example, a foot injury that isn't fully healed leads to a knee injury, as the athlete has changed kicking or standing technique and is putting abnormal force on the knee."

However, young martial arts athletes should be able to continue training, at least in some form, while waiting for lower extremity injuries to heal.

"I am always a big component of 'what can the athlete do' and making appropriate modifications in training to help deal with injury recovery," Koutures said. "With lower extremity injuries, most of these do not require a complete removal from training. There are upper body forms and drills that can be done, both from a standing [but no jumping, contact or impact] or even a sitting position if needed. Good sports medicine professionals can help create a modified plan and communicate with instructors. You can also look at number of repetitions [perhaps do fifty percent of kicks or jumps] or limit sparring but allow more form work."

Chris Klingenberg is a freelance writer based in Massachusetts.

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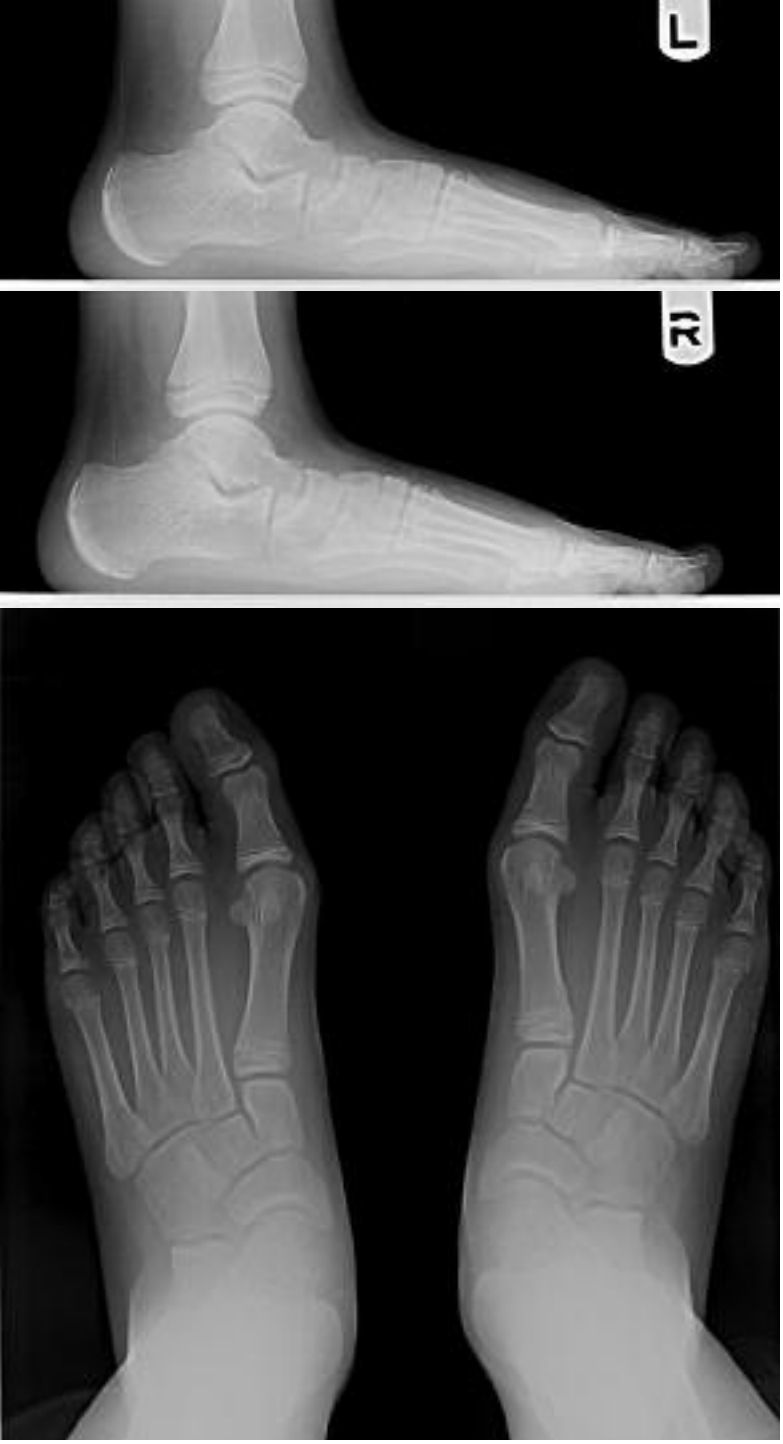

Lateral and anteroposterior images of bilateral feet in the same skeletally immature patient demonstrating pes planus. Note the lateral deviation of the midfoot on the rearfoot at the talonavicular joint. (Images courtesy of Christopher L. Reeves, DPM.)

Flatfoot questions: Risk factors and assessment

The proposed association between obesity and pediatric flexible flatfoot (PFF) may depend more on the reliance on subjective, 2D footprint-based assessments than true correlation. And recent research has identified another potential risk factor, whole body and joint hypermobility.

By Hank Black

As accumulating evidence continues to suggest the proposed association between obesity and pediatric PFF is largely the product of unsophisticated arch height assessment methods, a leading researcher in the area is calling clinicians' attention to a different risk factor.

Podiatrist Angela M. Evans, PhD, who has spent years analyzing factors that may be associated with PFF, recently issued a wake-up call for practitioners to have a heightened suspicion that children with flatter feet than expected for their age may have whole body or lower limb joint hypermobility.

"Most astute clinicians already are aware of this possibility," said Evans, who has a podiatry practice in Adelaide, Australia, and holds a research position at La Trobe University in Melbourne.

In a 2016 study published in the *Journal of Foot & Ankle Research*,[1] Evans and colleagues looked at the relationship between foot posture and body mass index (BMI), age, and ankle, lower limb, and whole body flexibility in a convenience sample of 30 healthy children aged 7 to 15 years. Clinical data assessed included BMI, Foot Posture Index (FPI), Beighton scale score,[2] lower limb assessment scale score (LLAS),[3] and left ankle lunge angle.

The group found no association between PFF and BMI, age, or gender. Interestingly, however, they found that PFF was associated with joint and whole body flexibility.

Given that hypermobility can be associated with morbidity that may persist across the lifespan,[4] the condition "is too often disregarded as being benign or even advantageous,"[5] the authors wrote.

"Whilst a small study, the findings are notable," Evans said. "We need to look in quite a structured way at why these children are maintaining flatfoot. Is there an underlying neurological issue? Is there an issue with muscular function or structure? Is there an unrecognized genetic issue, such as Marfan syndrome or Ehlers-Danlos syndrome? Maybe a difference in connective tissue?"

Of particular interest, she said, are children with hypermobile joints that exceed "childhood flexibility," and continue at an older

> "Sometimes PFF, when not usual for age, might be the start of a thread that discloses more about a child's overall health." —Angela M. Evans, PhD

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Pediatric flatfoot


Normal pediatric foot

Image courtesy of the American College of Foot and Ankle Surgeons.

age than when developmental flatfoot is expected.

"It's very important to question why could this be, and look further, because hypermobility is not always just more flexible joints," Evans said. "Some types of Ehlers-Danlos syndrome, for example, can have significant underlying cardiac and ocular conditions that can threaten the child's health and life. So we need to be mindful that sometimes PFF, when not usual for age, might be the start of a thread that discloses more about a child's overall health."

Associations between PFF and hypermobility have been previously reported in the literature[6,7] and are commonly observed clinically. But the complexities of hypermobility warrant closer investigation of these relationships, Evans said.

"Hypermobility may be specific to that child or it may be a familial pattern in first-degree relatives," she said. "Then again, we may be looking at hypermobility that is present and reducing with age. That may also be accompanied by muscular hypotonia, which, if not condition-associated, also often reduces with age, but may delay motor development." (see "Gait: The cornerstone of intervention," *In Step with Pediatric Hypotonia*, September 2013, page 8.)

Treating hypermobility

Management of generalized hypermobility has not been well studied, particularly in children, but tends to focus on improving posture, joint stability, and specific motor skills; protocols often include pain-free cognitive exercises to enhance proprioception and muscle strength.[8-11] The lack of evidence has made developing effective lower extremity interventions a challenge.

"Certainly benign joint hypermobility is well known since Beighton developed the concept years ago.[12] The question is how to manage it," said foot and ankle surgeon Gregory Guyton, MD, who practices at MedStar Union Memorial Hospital in Baltimore, MD. "Unfortunately, there's nothing you can do to truly tighten the plantar ligaments on the medial side of the foot if indeed they have ligament laxity. There are no exercises that would make any real difference."

Christopher L. Reeves, DPM, who practices at the Orlando Foot and Ankle Clinic in Orlando, FL, said he and his colleagues have had success with orthotic management of symptomatic PFF in young children with hypermobility.

"Our conservative management of hypermobility might be an aggressive L-type orthosis," Reeves said. "In a foot that's really hypermobile and symptomatic, I'll use a UCBL [University of California Biomechanics Laboratory] type. I find this works extremely well in younger kids, who tolerate it very well. Once they get to ten or twelve years old, especially if they have no previous experience with an orthosis, they find it too aggressive."

Reeves believes a stretching program helps in children with tightness in posterior muscles from the Achilles to the gastrocnemius complex.

"That's especially found in larger kids whose soft tissue structures don't always keep up with bone growth. Sometimes stretching allows kids to better tolerate their activity level overall," he said.

Although posterior muscle tightness may seem to suggest hypomobility, not the opposite, Reeves said he doesn't correlate the two. "One can have a hypermobile flexible flat foot [joint laxity] yet have tight soft tissue structures [tendons] about the ankle," he said. "I find that children with flat feet are tight in the gastrocsoleus complex, as well as in the hamstrings, and think an overall stretching program can be beneficial in the long run."

Surgical intervention in children with PFF is typically reserved for severe cases that have not responded to other treatments, but for these children, hypermobility can also complicate surgical efforts.

"If you have a case involving global ligamentous laxity, you can't really trust any reconstructions you do with that patient's own ligaments. So, if you have joint instability that requires a fusion, you're much better off relying on their bones than their ligaments," Guyton said.

Hypermobility can turn a straightforward surgical procedure into something more complex, Reeves noted.

"It depends on the patient, but in a simple case, I'll perform a realignment calcaneal hindfoot osteotomy," Reeves said. "Occasionally we'll also do a medial foot soft-tissue reconstruction because, after you've realigned the foot, there's a lot of laxity that needs to be addressed where that site's been stretched out."

The obesity question and PFF assessment

In the 2016 study by Evans et al, the lack of association between BMI and PFF is consistent with previous studies by the same research group[13,14] and contrasts with the findings of multiple other studies that used a different method of defining PFF.

It once seemed intuitive that overweight children are more likely than normal-weight children to have flat feet, and many studies have reached that conclusion.[15-21] Most of those studies, however, used a variety of at least partially subjective measures of foot morphology based on printed, scanned, or digitized footprints.

Evans's studies, in contrast, used the six-item FPI, which accounts for the 3D nature of foot posture and achieves good reliability in adults[22,23] and children.[22,24-26]

The six criteria used include: (1) talar head palpation; (2) curves above and below the lateral malleolus; (3) inversion/eversion of the calcaneus; (4) bulge in the region of the talonavicular joint; (5) congruence of the medial longitudinal arch; and (6) abduction/adduction of the forefoot on the rearfoot.

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Resting stance position in a pediatric patient demonstrating calcaneal valgus on the right foot and a rectus left foot. Comparisons are made as the calcaneus relates to the distal leg. (Photo courtesy of Christopher L. Reeves, DPM.)

Each criterion was given a score between -2 and +2, for which scores less than zero indicate a supinated alignment and scores greater than zero indicate a pronated alignment. Scores of all criteria were added to create an overall score for each foot from -12 (most supinated) to +12 (most pronated). The mean FPI score for the study population in Evans et al's 2016 paper was 2.8 ± 2.3.

"FPI is now seen as a repeatable, reliable measure with some levels of validation, and it is being increasingly used in a number of subjects, including some involving pediatric populations. It's relatively quick and simple to use," Evans said.

Clinically, however, FPI isn't yet universally accepted.

"FPI is a great research tool, although I don't know of anyone using it in general clinical practice," Evans said. "For me, it's all clinical evaluation, a visual analysis of gait, and a family history, with radiographs playing a huge role."

Guyton said he has used FPI for clinical screening.

"It has been validated against radiographs, and we use radiographs when we are assessing patients preoperatively," he said.

Amber Shane, DPM, a colleague of Reeves at the Orlando Foot and Ankle Clinic, also evaluates with x-rays and, to make sure the arch is flexible, the heel-rise test.[27]

"With flatfoot, you're going to see where the talus and the navicular that normally articulate about seventy five percent, you're going to see less than fifty percent," Shane said.

Evans said recent research is giving a clearer picture about the evaluation and classification of PFF. A 2016 report from Spanish researchers[28] used the FPI and, like Evans and colleagues, found no association between obesity and flatfoot. The same group also determined normative FPI values for children, though the participants' age range was limited to 6 to 11 years, and they were not overweight (average BMI 16.9). These normative data could be used to help clinicians identify children who need to be referred elsewhere for deeper analysis of gait or growth, and also to help monitor changes in physiological or pathological foot posture during childhood, the authors noted.

The predominance of footprint-based measures of flat feet in the PFF literature was clear in a 2015 systematic literature review by Stolzman et al that included studies through 2013.[29] The researchers analyzed 13 cross-sectional studies of varied designs. None used the FPI; most used a footprint-based measure, clinical examination, or other methods requiring some degree of subjectivity. Due to the few studies published that met study criteria, different methodolo-

gies used, lack of definition of pes planus, and few studies of pain and other potential complications, the authors of the review called for more research to determine the relationships between body weight, pes planus, and associated pain and function effects.

Stolzman et al did not include Evans's seminal 2011 study of 140 Australian schoolchildren, which utilized FPI to determine there was not a direct relationship between increased body mass and flatter feet.[13] That study was expanded and its results confirmed in a 2015 publication involving 728 children.[14] In it, Evans reviewed 11 studies from 2001 to 2013; her 2011 study[13] was the only one that did not find a significant relationship between foot posture and body mass.

Evans' current work includes preparing an update to the 2010 Cochrane Review she coauthored on nonsurgical interventions for PFF.[30] She has also has launched a new pediatric podiatry resource, Evidence Essentials, online at her website, angelaevanspodiatrists.com.au.

Even in the absence of a statistical association between BMI and PFF, both Reeves and Guyton noted symptoms associated with PFF can be exacerbated when kids become obese.

"Children who otherwise would manage with flat feet will get larger and suddenly the flatfoot becomes symptomatic," Guyton said. "The force on the arch is greater, or sometimes flatfoot becomes symptomatic because of lateral impingement with the arch collapses to the degree that the calcaneus impinges against the tip of the fibula."

Evans' proposal to use FPI instead of footprints to help diagnose pediatric flexible flatfoot wasn't her first run-in with a legacy practice. In a 2008 paper[31] Evans stirred up some practitioners by recommending that asymptomatic children whose feet are flatter than would be expected for their age group should not be automatically treated (with customized orthoses).

Her thesis to monitor or "address the basics" (footwear, strengthening, stretching) was based on studies[32-34] conducted as early as 1989 that showed no structural foot change in normal-weight children over a number of years versus controls.

"With the renaissance of evidence-based medicine, it behooves us as clinicians to be more scientific and informed about our approach," she told *LER* in 2010 (See "Numbers needed to treat? The pediatric flexible flatfoot debate," January 2010, page 22).

Guyton said he's seen no evidence for the prophylactic use of orthoses in kids with PFF who do not have symptoms.

"If the youngster has no symptoms and no secondary issues such as the ankle tilting, then the right answer is to do nothing," he said. "If the flatfoot becomes painful then we will usually try orthotics."

Reeves doesn't discount the use of orthoses even for asymptomatic patients.

"If the flatfoot is severe and asymptomatic, and the child can tolerate orthotic therapy well, I'll at least recommend orthoses if they feel better and their shoe fits better," he said.

Shane noted that symptoms can be more than just pain.

"Children with flexible flatfoot may tire before other children do, perhaps tripping or falling, [moving] slower on the athletic field, and feel clumsy in their shoes," she said. ler

Hank Black is a freelance writer in Birmingham, AL.

References are available at lerpediatrics.com.

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Early athletic specialization: Misconceptions and hazards

Most elite athletes didn't concentrate on one sport as adolescents, and there's a strong link between early sport specialization and physical injury and emotional burnout. Yet, many parents think this risky path is the only route to high achievement and college scholarships.

By P.K. Daniel

There is mounting evidence early specialization in sports not only increases the risk of overuse injuries, especially of the lower extremities, it also does not substantially increase the likelihood of competing in sports at college or professional levels.

The American Orthopaedic Society for Sports Medicine (AOSSM) concluded in its latest consensus statement that "there is no evidence that young children will benefit from early sport specialization in the majority of sports." Additionally, it noted: "[Children are] subject to overuse injury and burnout from concentrated activity. Early multisport participation will not deter young athletes from long-term competitive athletic success."[1]

Some experts have attributed the rise in overuse injuries and burnout among youth athletes to an overaggressive culture in competitive youth sports, including intensive training. Besides a 33.3% increase between 1997 and 2008 in organized sports participation among US children aged 6 years and younger, there has been an influx of travel teams (eg, baseball, softball, basketball) and club teams (eg, soccer, wrestling, volleyball, gymnastics) with players starting as young as 7 years.[2]

"[Parents] think those club sports are the exposure to the collegiate coaches, so they'll forego playing another sport so they can have more exposure in that one sport in the club-type setting," said Greg Myer, PhD, associate professor of pediatrics and director of research and the Human Performance Laboratory in the Division of Sports Medicine at Cincinnati Children's Hospital Medical Center in Ohio.

"The driving force is a college scholarship. They think they're creating the most opportunities for their kids. I think it's a very closed-minded approach. There are not many opportunities, but if their kid is an elite-level athlete, they'll certainly emerge, and they won't be missed by the recruiting coaches at the collegiate level," he said. An elite-level athlete is going to be scouted and get opportunities regardless.

Current evidence suggests delaying specialization for most sports until after puberty will minimize risks and increase chances of athletic success.

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Early specialization among elite athletes

The AOSSM defines early sport specialization with three criteria: Participation in intensive training and/or competition in organized sports greater than eight months per year; participation in one sport to the exclusion of participation in other sports (limited free play overall); and involving prepubertal children (younger than seventh grade or roughly age 12 years).[1]

Research shows those who played National Collegiate Athletic Association (NCAA) Division I sports were less likely to have specialized early than those who don't.[3] A study published in the November 2016 issue of *Sports Health* reaffirmed the AOSSM statement, concluding that, while most prospective college athletes will eventually specialize in their respective sports, early specialization is not necessary to achieve Division I athlete status.[4]

The study, conducted by University of Wisconsin-Madison researchers, surveyed 343 athletes (115 women) from nine sports from a Midwest Division I university. Most of these athletes did not specialize in high school. Although there was no difference between genders at any grade level, the percentage of athletes who specialized increased as they advanced through high school, with 16.9% of ninth graders specializing and 41.1% of 12th graders concentrating on one sport. The University of Wisconsin study also noted football players were significantly less likely to be highly specialized than nonfootball athletes for each year of high school.[5]

Specialization was classified as low, moderate, or high using a previously published three-point scale method that was based on a questionnaire completed by the athletes. Assessing their sports specialization, a "yes" answer was worth 1 point, a "no" answer, 0. The questions: 1) "Do you participate in year-round intensive training in a single sport at the exclusion of other sports?" 2) "Have you quit other sports to focus on one sport?" 3) "Do you train more than 8 months out of the year in one sport?" and 4) "Do you consider your primary sport more important than other sports?" A total score of 3 was defined as high specialization; a score of 2, moderate specialization; and a score of 0 or 1, low specialization.[6]

The American Academy of Pediatrics and its Council on Sports Medicine and Fitness in Pediatrics in September 2016 issued a report with statements similar to the AOSSM's:

"Current evidence suggests that delaying sport specialization for the majority of sports until after puberty will minimize the risks and lead to a higher likelihood of athletic success."[7] Its report included data from TrackingFootball.com, which reported that, of the 322 players who were invited to the 2015 National Football League (NFL) Scouting Combine, 87% had played multiple sports in high school.[18]

Injury risks and management

Cynthia LaBella, MD, contributor to several studies on early sports specialization, is associate professor of pediatrics at Northwestern University's Feinberg School of Medicine in Chicago and medical director for the Institute for Sports Medicine at the Ann & Robert H. Lurie Children's Hospital of Chicago. She noted the danger of early sports specialization to still-developing youth athletes, particularly in the lower extremities.

"In young kids who are still growing, the most common are overuse injuries [Osgood-Schlatter syndrome], which is inflammation of the patellar ligament at the tibial tuberosity causing knee pain, and Sever disease [inflammation in the heel] to the growth centers," LaBella said. "Less commonly, these athletes will get stress fractures in the common places [ie, metatarsals, tibia, femur]."

LaBella said lower extremity clinicians can advise young athletes and their families not to play through pain. "Typically, the main culprit for developing an overuse injury is an abrupt change to the training schedule, or inadequate time off during the week or over the course of the year," she said. "We advise at least one to two days off per week, and one to two months off per year [from the child's main sport]. There are sometimes additional factors contributing to their injury, such as imbalance of muscle strength or flexibility, generalized ligamentous laxity, or anatomic variants of normal alignment such as pes planovalgus or femoral anteversion. Physical therapy, shoe inserts, and temporary functional bracing are often helpful to address these additional factors."

Research on injury prevention in youth athletes supports some of these strategies, though the precise degree of sport specialization among study participants isn't typically specified. Emery et al,[9] for example, found a home-based proprioceptive balance-training program improved static and dynamic balance in healthy adolescents and reduced incidence of self-reported injury over six months. Similarly, Wedderkopp et al[10] found young female handball players using an ankle disc along with functional strengthening at each practice session were less likely to be injured than a group that did functional strength training only.

"There is limited data on the effect of braces on injury prevention," said LaBella. "The few studies on knee braces have shown no significant reduction in injury rates.[11,12] However, studies of high school football and basketball athletes have shown that a semirigid ankle brace was effective in reducing the risk for both first-time ankle sprain and recurrent sprain."

A 2010 study found lace-up ankle braces can significantly reduce the risk of ankle sprain in high school basketball players, even those with no history of injury (See "Lace-up ankle braces reduce risk of sprain in basketball players regardless of history," *LER*, May 2011, page 24). Other research has found prophylactic ankle braces increased dynamic postural control and functional test scores among high school basketball players,[13] and a review of prophylactic ankle bracing studies found moderate evidence to support using

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prophylactic ankle braces in adolescent athletes, particularly football and basketball players, to reduce acute ankle injury incidence.[14]

LaBella also said that in her subspecialty clinic, which focuses on young athletes, clinicians take a detailed history about sports participation, including how many and which sports patients play, how much they train, and any recent changes in intensity, volume, or frequency.

"We then recommend temporary modification to their training regimen to keep them active but within a pain-free window of activity, and then, once their injury has healed, we advise them how to structure a gradual progression back to their sport to avoid recurrence," she said. "Sometimes with an athlete who is specialized in a single sport, we may recommend they participate in a complementary sport at a recreational level to help balance their muscle recruitment. For instance, for a swimmer, we might advise cycling or running."

In cases in which specialization is presumed to be nonnegotiable, such as with elite-level gymnasts, the injury-prevention model and rehab may differ from the prevention and rehab for a multisport kid. "The main focus should be balancing muscle strength and flexibility deficits, and encouraging recreational activities that are complementary and, most importantly for kids, fun," said LaBella.

Neeru Jayanthi, MD, a contributor to the AOSSM consensus statement and associate professor of sports medicine at Emory University in Atlanta, GA, said individual and technical sports like gymnastics, tennis, and dance, present a higher risk of injury to children who specialize.

USA Gymnastics, the sport's governing body, advises the optimal training plan for elite gymnasts is two workouts per day, totaling five to seven hours, six days a week. Jayanthi said the gymnastics community believes in putting in whatever time is necessary—even if that means risking injury. "In those individual, technical sports, the mindset isn't going to change anytime soon," he said. "[But] you have to work within that context. Until we put out a gymnastics study that really outlines performance and [shows the current methods are counterproductive], it's just accepted that some people are going to get hurt."

Jayanthi, who is also president of the International Society for Tennis Medicine and Science, suggested during the AOSSM consensus development that getting governing bodies on board requires large, sport-specific studies looking at the performance benefits of not specializing.

Another study recently conducted by the University of Wisconsin-Madison concluded injury rates for athletes who specialized in one sport were higher than for athletes who played multiple sports, and that rates for lower extremity injuries were significantly higher.[15] The researchers surveyed 1500 student-athletes—750 girls and 750 boys—during the 2015-2016 school year at 29 Wisconsin high schools. The student-athletes were defined "specialized" if they answered "yes" to at least four of the following six questions: 1) "Do you train more than 75 percent of the time in your primary sport?" 2) "Do you train to improve skill and miss time with friends as a result?" 3) "Have you quit another sport to focus on one sport?" 4) "Do you consider your primary sport more important than your other sports?" 5) "Do you regularly travel out of state for your primary sport?" and 6) "Do you train more than eight months a year in your primary sport?"[15]

More than a third (34%) were specialized. Girls, at 41%, were more likely to specialize than boys (28%). Soccer had the highest


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percentage of sports specialists among all sports for both genders (girls 48%, boys 45%). Next was softball (45%), followed by volleyball (43%) and basketball (37%) for girls and basketball (37%), tennis (33%), and wrestling (29%) for boys.[15]

The study, funded by the National Federation of State High School Associations (NFSH) and published in the January 2017 issue of *High School Today*, said student-athletes who specialized were nearly twice as likely (46%) to report previously sustaining a lower extremity injury while participating in sports than athletes who did not specialize (24%). Also, these single-sport athletes had 60% more new lower extremity injuries, which were defined as "any acute, gradual, recurrent or repetitive-use injury to the lower musculoskeletal system" suffered during the 2015-2016 school year.[15]

The most common type of previously self-reported ailments were ligament sprains at 51% and muscle/tendon strains at 20%. The ankle (43%) and the knee (23%) were most often identified by the student-athletes as the injured area among previous lower extremity injuries. The ankle (34%), followed by the knee (25%) and upper leg (13%) led the list of locations of new injuries reported during the yearlong study. Ligament sprains (41%), muscle/tendon strains (25%), and tendinitis (20%) were the most common type of injuries.[15]

Multisport benefits

Greg Myer noted, "Some of our most elite-level athletes have played multiple sports, even at the high school level."

Jared Goff, the number-one overall pick in 2016's NFL Draft, played football, basketball, and baseball in high school, while number-four overall pick Ezekiel Elliott played basketball and ran track. In fact, 26 of the 31 first-rounders played multiple sports in high school, according to TrackingFootball.com.[8]

Myer said parents should know early sports specialization "is probably not going to make their kid the best athlete they can be, but if you are going to specialize and be skill-oriented, you need periods of resistance training and neuromuscular training to help build some of those motor-control strategies you might miss by playing specialized sports."

As he's pointed out, the chances of playing at the next level are limited. Even the likelihood of playing at the high school level, let alone in college or the pros, is relatively poor. Little League International reports that fewer than 10% of the five million kids who play youth baseball will play baseball in high school. The NCAA reported in 2016 that only 7% of the 486,567 high school baseball players in 2014-2015 advanced to play in college. Only 2.1% made it to Division I.[16,17] And chances of making it to the pros? Even slimmer. Multiple sources report only .5% of high school seniors will ever be drafted by a Major League Baseball team.[18] The figures for other sports are similar. Fewer than 1% of athletes aged 6 to 17 years will reach elite status in basketball, soccer, softball, or football.[2]

Myer also thinks there's a presumption by parents and coaches that they know which sport is in the child's best interest even when his or her exposure has been limited. "The biggest concern I have with early sports specialization is how do any of these kids know the sport that they're specializing in is their true sport or what they're good at?" he asked. He attributes part of that issue to the lack of access today's children have to physical education at school, which once exposed children to multiple sports. "Now, these kids are having fewer opportunities there, and then they're being pushed to specialize," he said. "They are more than likely not even specializing in their best sport."

John Labeta is the assistant commissioner of the California Interscholastic Federation-San Diego Section (CIF-SDS). Over his three-decade career, including roles as a coach, athletic director, and administrator helping oversee 127 high schools, Labeta has seen the change in emphasis from multisport athlete to specialist.

"Very few specialized [25 years ago], as coaches encouraged participation in more than one sport," Labeta said. "Most athletes did something else after their season of sport. Field hockey players did soccer or softball. Football players wrestled, played basketball, or soccer. Basketball players ran track or cross country or played baseball. Athletes were athletes, and you improved your skill level by playing more than one sport."

In those days, Labeta noted, some athletes played on more than one team in the same sport. "But not because they thought they were going to get a scholarship or their parents got to brag about them being on a select team," he said. "They played because they loved the sport." ler

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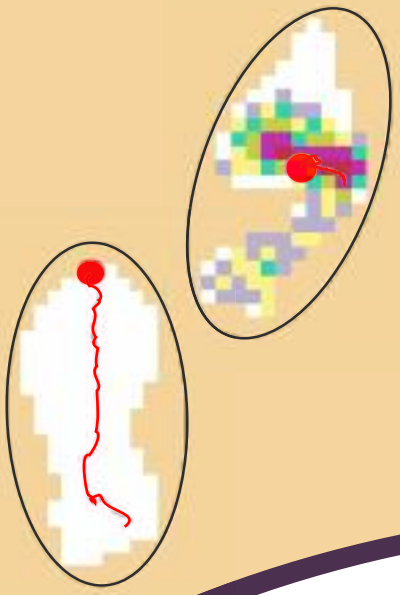

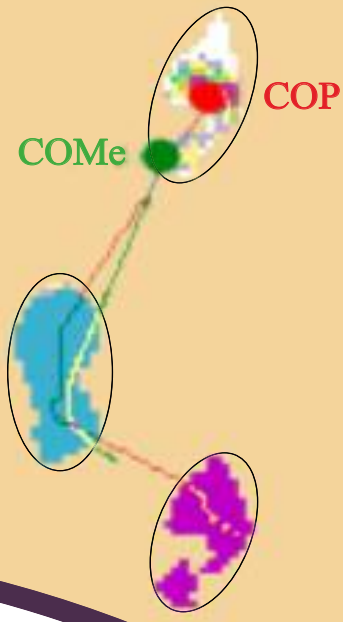

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