

# Foot & Ankle RESEARCH REVIEW™

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Issue 53 – 2022

## In this issue:

- Dynamic foot classification: Functional grouping of ankle joint frontal plane motion
- In-shoe and barefoot placed frontal wedge effects on plantar loading
- Biomechanical gait assessments of adolescent musculoskeletal injuries
- Biomechanics of foot orthosis and low-dye tape for pes planus
- Customised preformed foot orthoses in juvenile idiopathic arthritis
- Experience of podiatry care for diabetes-related foot ulcers
- Customised dynamic ankle-foot orthoses
- Running economy in carbon-fibre plate racing shoes
- Prevalence of injuries in trail running
- Self-lacing technology and foot containment during dynamic cutting

### Abbreviations used in this issue

RCT = randomised controlled trial

VO<sub>2</sub> = oxygen consumption

## Welcome to Issue 53 of Foot and Ankle Research Review.

In this issue I highlight some recent publications surrounding foot motion and foot orthoses. I was excited to read the article by Chalmers et al., who investigated a method to classify dynamic foot function. This is a significant shift in thinking from our current static-based assessments. It was also good to read of the progressing evidence for the use of foot orthoses in children with juvenile idiopathic arthritis.

I hope you enjoy this issue.

Noho ora mai

Associate Professor Matthew Carroll

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Research Review thanks Foot Science International for their sponsorship of this publication and their support for ongoing education for healthcare professionals.

## A step towards dynamic foot classification: Functional grouping using ankle joint frontal plane motion in running

**Authors:** Chalmers O et al.

**Summary:** This study assessed the use of dynamic assessments and classification of feet based on functional motion by examining 42 runners to determine the existence of homogenous sub-groups of ankle joint complex (AJC) frontal plane motion. Analysis identified 2 distinct clusters, with cluster 1 displaying less AJC eversion ( $p < 0.001$ ) between 0% and 97% of the stance phase versus cluster 2; the between cluster differences were associated with large effect sizes. Cluster 1 was defined as a Neutral Dynamic Foot Type and cluster 2 a Pronated Dynamic Foot Type. This foot type measure had only limited agreement with the Foot Posture Index (FPI-6).

**Comment:** Can we predict dynamic motion based upon static measures of foot shape? The results of this research propose we cannot. The authors present a functional grouping technique whereby AJC kinematics during running were used to classify foot motion. The proposed approach overcomes the need to predict motion from static morphology and demonstrates a method to classify feet based upon motion. The research found little agreement between the FPI (a commonly used measure to quantify static foot position) and the AJC kinematic motion. This finding indicating static classification of foot position is not reflective of dynamic function. Consequently, we must now consider the usefulness and validity of static foot assessments when prescribing treatments that target dynamic function.

**Reference:** *Gait Posture* 2022;97:35-39

[Abstract](#)

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## Impact of in shoe and barefoot placed frontal wedges on plantar loading: A systematic review

**Authors:** Magdalena M-R et al.

**Summary:** This systematic review examined the effect of different types of in-shoe and barefoot wedges on plantar loading distribution based on 11 studies (4 cross-over studies, 4 quasi-experimental studies, 3 RCTs) including 320 patients (aged 20-60 years). Most of the observational studies and RCTs had a moderate level of quality. Lateral frontal plane wedges appeared to be the most effective, producing a lateral centre of pressure shift and increasing pressure. Peak impact force across the published data was less consistent.

**Comment:** This review examined the literature to determine the effects of frontal plane wedges on plantar pressure loading. For the purposes of this review frontal plane wedges included types: valgus or varus wedges, lateral wedges, medial wedges, forefoot wedges, and rearfoot wedges. The review highlighted that lateral and medial wedges shift the centre of pressure laterally and medially respectively, but the effect of frontal plane wedging on peak pressures was unclear. The review is limited as it did not investigate the additional effects that wedge inclination height, wedge placement and wedge material type have in alteration of plantar pressures. Being that foot wedging is frequently used in clinical practice we still require more direct clinical guidance from research to optimise outcomes.

**Reference:** *Gait Posture* 2022;97:62-72

[Abstract](#)

## Biomechanical running gait assessments across prevalent adolescent musculoskeletal injuries

**Authors:** DeJong Lempke AF et al.

**Summary:** This cross-sectional study assessed biomechanical profiles (3-D video analyses and instrumented treadmill) that may be associated with prevalent musculoskeletal lower extremity injuries among 149 injured adolescent runners. Patients experiencing bony injuries had higher maximum vertical ground reaction forces than those with soft tissue injuries (1.87 vs 1.79 body weight;  $p = 0.05$ ), and more patients had contralateral midstance pelvic drop ( $p = 0.02$ ). The maximum vertical ground reaction force and pelvic drop measures were weakly correlated ( $p = 0.20$ ,  $p = 0.01$ ). More patients with hip and knee injury presented with forefoot strike patterns ( $p = 0.01$ ).

**Comment:** The authors present a few interesting findings. Firstly, adolescent runners with bony musculoskeletal injuries presented with increased maximal loading compared to runners with soft tissue injuries. Secondly, the authors propose their findings support the theory that exposure to high, repetitive loading may result in mechanical tissue failure of static anatomic structures leading to bone stress injuries. Thirdly, adolescents may not be directly compared to adult runners, and that overall higher normalised forces may be expected among adolescent athletes regardless of injury type. Finally, data indicated that contralateral pelvic drop provided evidence of inadequate dynamic stabilisation and was more frequently observed among adolescent runners with bony injuries.

**Reference:** *Gait Posture* 2022;96:123-129

[Abstract](#)

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### Independent commentary by Associate Professor Matthew Carroll

Matthew is an Associate Professor of Podiatry at Auckland University of Technology. His research focus is on chronic long-term conditions that affect the foot. He is a current Editorial Board member for the Journal of Foot & Ankle Research, Academic Editor for PLOS ONE, and past Associate Editor for BMC Musculoskeletal Disorders.



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## The effects of foot orthosis and low-dye tape on lower limb joint angles and moments during running in individuals with pes planus

**Authors:** Ataabadi PA et al.

**Summary:** This study examined the effects of foot orthoses and low-dye tape on lower limb biomechanics, specifically joint angles and moments, during running in 20 patients with pes planus while wearing shoes with or without foot orthoses or low-dye tape. Foot orthoses reduced ankle eversion versus shoes alone and compared with shoes and low-dye tape ( $p < 0.001$ ), and decreased dorsiflexion angle ( $p = 0.005$ ) and plantar flexor moment versus shoes alone ( $p < 0.001$ ). Foot orthoses also increased knee adduction angle ( $p = 0.021$ ) and external rotator moment ( $p < 0.001$ ) versus shoes alone and shoes with low-dye tape and increased knee extensor and abductor moments versus shoes alone ( $p < 0.001$ ). Foot orthoses only increased hip external rotation versus shoes with low-dye tape ( $p = 0.031$ ), while low-dye tape increased hip extensor moment versus shoes alone and shoes with low-dye tape ( $p = 0.037$ ), and increased hip adduction angle versus shoes alone ( $p = 0.037$ ).

**Comment:** I was intrigued by this study as the authors used 3-D gait analysis to examine the effect of foot taping on motion. The research concluded that low-dye taping has no impact on the ankle joint, implying that simple taping cannot prevent excessive pronation of the foot in people with pes planus. This supports previous research findings, and many may not find this result surprising. This finding should again make us think about the role of foot taping as a frontline treatment for foot injuries. I was interested in the findings related to the foot orthoses and care must be taken when considering some of the statements made by the authors in light of several limitations that were not considered. Namely, the dose-response relationship of orthoses was not considered, all foot orthoses were manufactured to the same specifications. Secondly, running foot strike patterns were not considered. Did the effect of the orthoses differ due to differences in strike patterns?

**Reference:** *Gait Posture* 2022;96:154-159

[Abstract](#)

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## Effect of customised preformed foot orthoses on gait parameters in children with juvenile idiopathic arthritis: A multicentre randomised clinical trial

**Authors:** Fellas A et al.

**Summary:** This 6-month, multicentre, parallel design, single-blinded randomised clinical trial assessed the gait impacts of customised preformed foot orthoses (low-density full length, Slimflex Simple device) versus a sham device in 66 children with juvenile idiopathic arthritis (JIA). Customised preformed foot orthoses altered plantar pressures in children with JIA versus sham, with reductions in peak pressures and pressure time integrals in the heel, forefoot and 5<sup>th</sup> metatarsophalangeal joint. This was associated an increased midfoot contact at baseline, and at 3 and 6 months. The foot orthoses were safe and well accepted with a high retention rate (92%) over the period of the trial.

**Comment:** This Australian-based study provides evidence that foot orthoses play an important role with regard to plantar pressure reduction in children with JIA. I particularly like that the foot orthoses used for the research were readily available preformed orthotics, that are easily customisable. As with many foot orthosis-based research, longer-term effects are not so evident. In the case of this research, heel pressure and pain level differences at 6-month follow-up were not different between the control and trial groups. The authors attributed the reduced longer-term effects to degradation of the materials in the foot orthoses. This raises interesting questions about adaptation to orthoses and if material properties of orthoses are as important as the supposed support they provide.

**Reference:** *Gait Posture* 2022;95:93-99

[Abstract](#)

## Investigating the experience of receiving podiatry care in a tertiary care hospital clinic for people with diabetes related foot ulcers

**Authors:** Ong EKM et al.

**Summary:** This qualitative study explored the lived experience of podiatric treatment for diabetes-related foot ulcers through semi-structured interviews with 10 male patients (mean age 69 years) treated in a tertiary outpatient setting. Thematic analysis identified 4 themes: 'Trusting the podiatrists with the right expertise' – professional behaviour, including high organisation and hygiene practices and demonstrated expertise, were identified as key factors influencing trust in a podiatrist; 'Personalised care' – information tailored to individual needs was helpful; 'Happy with the service, but not always with prescribed care' – use of offloading devices and dressing of ulcers were often burdensome; and 'It's a long journey' – podiatric treatment of foot ulcers was a lengthy and onerous experience.

**Comment:** This Australian study examined patients lived experience of podiatric care who had suffered diabetes-related foot ulceration. One of the interesting findings related to a person's ability to trust their podiatrist, trust being a key facilitator for a positive treatment experience. Trust was achieved when podiatrists demonstrated professional expertise in communication, ulcer debridement, and use of appropriate dressings. The study also advocates for the importance of tailoring health advice to meet patient's needs. The research also reinforces the struggle patients have with acceptance of their foot ulcer, the burden of associated treatment, and a generally negative outlook for their foot health.

**Reference:** *J Foot Ankle Res.* 2022;15(1):50

[Abstract](#)

## Design principles, manufacturing and evaluation techniques of custom dynamic ankle-foot orthoses: A review study

**Authors:** Rogati G et al.

**Summary:** This review assessed the state-of-the-art and current limitations of passive dynamic-ankle-foot orthoses (PD-AFOs) for drop-foot patients with less severe ankle weakness. PD-AFOs feature a flexible calf shell that bends and absorbs energy during the walking stance phase and releases it to support the limb in the push-off phase. A total of 75 research papers were grouped according to macro-topics; 16 focused on scanning technologies and geometry acquisition, 14 on customisation criteria, 19 on production techniques, 16 on mechanical testing, and 33 on functional testing. Analysis suggested that the design and production of custom PD-AFOs is increasingly feasible with advances in 3-D scanning and additive manufacturing, and custom PD-AFOs provided better comfort and improved spatiotemporal parameters than standard solutions. However, there is no customisation principle to adapt PD-AFO stiffness to degree of ankle impairment or mechanical/functional demand.

**Comment:** This review provides a good overview of design principles of ankle foot orthoses. Specifically, the review covers customisation criteria, production techniques, mechanical testing, and functional evaluation. The review is easy to read and provides a good knowledge upskill.

**Reference:** *J Foot Ankle Res.* 2022;15(1):38

[Abstract](#)

### CONGRATULATIONS TO

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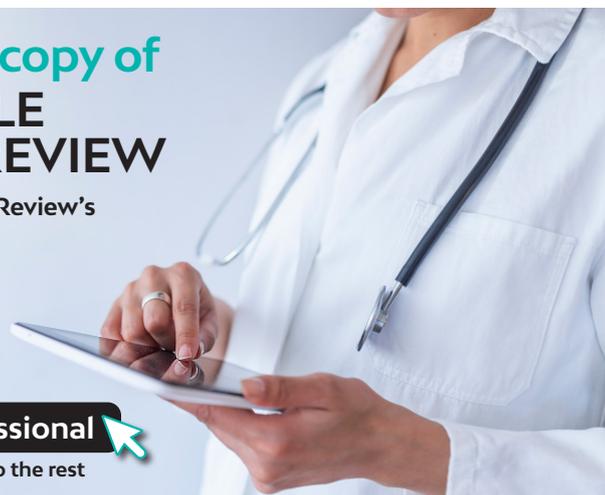
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## A comparison of running economy across seven highly cushioned racing shoes with carbon-fibre plates

**Authors:** Joubert DP & Jones GP

**Summary:** This study assessed running economy among 7 highly cushioned racing shoes with a carbon plate compared with a traditional racing shoe in 12 male runners (mean best 5000 m time 16.0 min) over 8 × 5-min trials at 16 km/hr in two testing sessions. Mean  $VO_2$  suggested similar running economy in the Asics HYPER SPEED™ traditional racing shoe (51.71 mL/kg/min), Hoka Rocket X (51.67 mL/kg/min) and Brooks Hyperion Elite 2 (51.42 mL/kg/min) carbon plate shoes. While Saucony Endorphin Pro (50.93 mL/kg/min; -1.48%) and New Balance RC Elite (50.99 mL/kg/min; -1.37%) carbon plate shoes were superior to the Asics HYPER SPEED™, but were inferior to Nike Alphafly (50.13 mL/kg/min; -3.03%), Vaporfly NEXT% 2 (50.29 mL/kg/min; -2.72%), and Asics METASPEED™ Sky (50.39 mL/kg/min; -2.52%) carbon plate shoes.

**Comment:** If you follow running shoe development you will be aware there appears to be an arms race across running shoe companies to produce carbon-fibre plated shoes that provide improvements in running economy. The study found that the Nike Alphafly and Asics METASPEED™ Sky shoe produced similar improvements in running economy compared to the Nike Vaporfly Next% 2. The authors note that not all racing shoes with carbon-fibre plates result in equal improvements in running economy. They suggest that the midsole material (the foam) is crucial to the economic benefits of the shoe. Plate geometry and foam technology varies widely amongst all brands but comparison is difficult due to the use of proprietary foam names. There will definitely be more research developments around these so-called super shoes in the coming years as companies strive for shoes to further enhance running performance.

**Reference:** *Footwear Sci.* 2022;14(2)71-83

[Abstract](#)

## The prevalence of injuries in trail running: Influence of trails, terrains and footwear

**Authors:** Hamill J et al.

**Summary:** This US online retrospective questionnaire examined the prevalence and anatomical location of injuries occurring during trail running, along with type of trails and terrains and type of footwear among 1016 participants. Overall, 359 respondents reported 872 injuries, with the most commonly reported injury being a rolled or sprained ankle. There was a significant association between injury and preferred trail and terrain types. Most (75%) trail runners wore trail running footwear, but there was no association between use of footwear designed for trail running and injury risk. Traumatic ankle injuries were more prevalent in trail running and chronic knee injuries more common in road running.

**Comment:** This American survey of 1016 runners reported some novel findings related to injury and shoe type. Forty percent of participants reported sustaining an injury during running on a trail. Acute injuries such as rolled or sprained ankles being the most common injury. Type of running surface also appeared to influence the severity of injury type, with injuries such as fractures more likely to occur on highly technical terrain. Most chose a trail running shoe based on the traction, cushioning and protection provided by the shoe. A question I have often wondered about was also answered by the research, the study finding the type of footwear used did not appear to mitigate trail running injuries.

**Reference:** *Footwear Sci.* 2022;14(2)113-121

[Abstract](#)



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## The impact of self-lacing technology on foot containment during dynamic cutting

**Authors:** Myers CA et al.

**Summary:** This study assessed the impact of basketball shoe self-lacing systems with 3 conditions of increasing lace tension versus a control basketball shoe by measuring relative foot-shoe motion using high-speed stereo radiography during cutting and jab step activities in 20 healthy athletes. The self-lacing system significantly reduced foot-shoe motion by up to 75.2% while performing dynamic basketball cuts. The lacing system allowed flexibility in containment from a loose fit to a tight fit, which reduced in-shoe motion by up to 39.3%. Perception data suggested athletes had 20.1% greater confidence to perform cutting tasks with greater lace tension.

**Comment:** I have often wondered how lacing potentially impacts injury to the ankle and foot. Does having a shoe laced loose (thereby increasing in-shoe foot motion) increase the prevalence of injury during sports such as netball or basketball? This study compared in-shoe foot motion between a standard laced basketball shoe and a motorised self-lacing shoe (Nike Adapt BB). The self-lacing shoe reduced foot motion during a series of cutting-based exercises. The Nike Adapt shoe allows the wearer to self-select the lace tightness from a loose to tight fit. Data reported that when going from a loose to tight fit, in-shoe motion reduced by approximately 39%. Reductions in sliding of the foot within the shoe and improved foot containment may have implications to improved performance and reduced injury risk. It will definitely be interesting to see this area of research grow.

**Reference:** *Footwear Sci.* 2022;14(2)94-102

[Abstract](#)



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