Response to Opponent's Report on PhD thesis "*Effect of footwear drop on running biomechanics and finite element analysis in recreational runners*"

Dear Dr. Tej Singh,

Thank you for your report for my PhD thesis, entitled "***Effect of footwear drop on running biomechanics and finite element analysis in recreational runners***". The suggestions offered by the reviewer has been immensely helpful, and we also appreciate your insightful comments on the topic, formal, style, methods, results, publications, thesis points, and specific questions.

I truly appreciate the time and effort you dedicated to reviewing our work. I have made comprehensive revisions in accordance with the points raised. Attached is a summary outlining the specific changes made throughout the manuscript for your reference.

Ph.D. Candidate
Quan Wenjing
Doctoral School of Chemical Engineering and Material Sciences
Faculty of Engineering
University of Pannonia
Egyetem u. 10, 8200, Veszprem, Hungary.

Supervisor
Dr. habil. FEKETE Gusztáv

Doctoral School of Chemical Engineering and Material Sciences, University of Pannonia

Senior Research Fellow at Vehicle Industry Research Center, Széchenyi István University

Egyetem tér 1. 9026, Győr, Hungary

Specific questions

1. *This dissertation utilized the finite element method to analyze the internal biomechanics of the foot during the four stance phases. Hence, my first question is, why analyze the four stance phases for the variables? Additionally, What are the functions of metatarsal and mid-foot bones in running?*

Answer:

The decision to analyze the internal biomechanics of the foot during the four stance phases using the finite element method was guided by the objective to obtain a comprehensive understanding of the foot's biomechanical behavior throughout the entire gait cycle. Each phase of the stance - initial contact, loading response, midstance, and terminal stance - presents unique challenges and stresses to the foot. By examining these phases separately, we can gain a more detailed and nuanced understanding of how the foot adapts and responds to different loads and movements during running.

Regarding the functions of the metatarsal and mid-foot bones in running, these structures play critical roles. The metatarsal bones, which form the bridge between the ankle and toes, are pivotal in distributing weight and providing the necessary leverage for forward propulsion. During running, they bear significant load during the toe-off phase, facilitating efficient energy transfer and forward movement.

The mid-foot bones, comprising the arch of the foot, are essential for shock absorption and adaptability on varied surfaces. They act like a dynamic spring, absorbing impact during initial ground contact and then releasing stored energy to aid in propulsion. This ability to absorb and release energy not only makes running more efficient but also helps in reducing the risk of injuries by minimizing the stress on bones and joints.

In summary, analyzing the four stance phases allows for a detailed understanding of foot biomechanics during running, highlighting the specific roles of the metatarsal and mid-foot bones in weight distribution, shock absorption, and propulsion.

2. *This dissertation mainly compares the biomechanics variables different with different heel-drop shoes. Thus, my second question is, In the design process of running shoes, how should the heel difference of the shoes be designed to reduce sports injuries and improve sports performance? Can the concept of heel difference in running shoes also be applied to the design of basketball shoes?*

Answer:

In designing running shoes, the heel-drop (or heel-to-toe drop) is a critical factor that should be tailored to minimize sports injuries and optimize performance. Heel-drop refers to the difference in height between the heel and the forefoot of the shoe. The ideal heel-drop varies depending on the runner's foot strike pattern, biomechanics, and personal preferences.

For runners with a heel-strike pattern, a higher heel-drop (around 8-12 mm) can be beneficial as it provides increased cushioning and support, reducing the impact on the heel and potentially preventing injuries like plantar fasciitis or Achilles tendinitis. Conversely, for mid-foot or forefoot strikers, a lower heel-drop (0-4 mm) is often preferable, as it promotes a more natural running gait, improving running efficiency and potentially reducing the risk of knee-related injuries.

Additionally, the right heel-drop can aid in enhancing performance. A lower heel-drop can encourage a more natural foot motion, leading to better energy efficiency. However, it's crucial to transition gradually to lower heel-drops to allow the body to adapt, reducing the risk of injuries due to sudden changes in running mechanics.

Regarding basketball shoes, while the concept of heel difference can be applied, the design considerations are somewhat different due to the nature of the sport. Basketball involves a lot of jumping, quick directional changes, and lateral movements. Therefore, basketball shoes typically have a higher heel-drop to provide extra cushioning for impact protection, especially on the heel, which is crucial during jumps and landings. However, too high of a heel-drop might hinder agility and stability. Thus, a balanced approach is needed to provide both protection and performance benefits.

In conclusion, the design of heel-drop in shoes should be sport-specific, considering the unique movements and biomechanical demands of each sport. While the fundamental concept of heel difference is applicable across different types of sports shoes, the optimal design and degree of heel-drop will vary between running and basketball shoes, reflecting the distinct needs of each sport.