The Effects of Cushioning Shoes on Running Biomechanics and Injury Risk

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ABSTRACT

Cushioning shoes have gained popularity among athletes due to their potential to reduce impact forces and enhance performance. However, their effects on running biomechanics and injury risk, particularly concerning anterior cruciate ligament (ACL) injuries, remain unclear, while training for practical enhancement out of the field like enhancing endurance or simply active cooldown sessions. This literature review examines the influence of maximal cushioning footwear on running biomechanics and explores the implications for ACL injury risk in runners and athletes engaged in contact sports such as American football and soccer. By synthesizing current research, the author aims to provide insights into whether maximal cushioning shoes may mitigate or exacerbate biomechanical factors associated with ACL injuries. Findings suggest that while maximal cushioning shoes may alter lower limb kinematics and kinetics, the relationship with ACL injury risk is complex and warrants further investigation.

Keywords: *Running biomechanics, ACL injury, Injury risk, Contact sports*

1. *INTRODUCTION*

The ACL plays a critical role in knee stability, and its injury is a significant concern for athletes across various sports, particularly those involving quickness, agility, pivoting, and rapid deceleration [1]. ACL injuries can lead to long-term functional deficits and an increased risk of osteoarthritis [2]. While ACL injuries are frequent in contact sports such as American football and soccer, they also occur in runners due to biomechanical factors that stress the knee joint, however other cofounding factors such as twists or previous injury and previous muscle exhaustion might be igniting the ACL injury [3, 4]. Nevertheless, ACL injuries are not just bound to performance, having a healthy life style and even in such terms of being active both in physiological and psychological terms are to be considered as important as performance [5-7]. There are other psychological factors involved as well, which can have long-lasting impact not only on the athletic career but the performer life as well.

Footwear is a modifiable factor that can influence running biomechanics and potentially affect injury risk. Different cushioning shoes as such maximal traditional and minimal can be described in this context. Maximal cushioning shoes as one, known by increased midsole thickness and enhanced shock absorption, have become increasingly popular among runners and athletes. These shoes are designed to reduce impact forces and provide enhanced comfort for not just the sole of the foot but rather the body, both while performing kinematics wisely and easing the entire body-running economy wisely during prolonged activities.

However, the effects of different cushioning shoes on lower limb biomechanics, but not just limited to, particularly concerning ACL injury risk, are not well understood. Alterations in kinematics and kinetics due to footwear may influence loading patterns on the knee joint, which eventually potentially affecting the risk of ACL injury, however not just limited to ACL and there are other cofounder effects as well, to be named, individuals background the intensity of performance, age and sex. This literature review thus aims to examine the current evidence on how cushioning shoes affect running biomechanics and to explore the implications for ACL injury risk in runners and athletes participating in contact sports. Understanding these relationships is essential for informing footwear recommendations and injury prevention strategies, in which both athletes and individuals may benefit from.

2. Method

A comprehensive literature search was conducted using databases such as PubMed and Google Scholar up to September November 9th, 2024. Keywords used in the search included "maximal cushioning shoes," "running biomechanics," "ACL injury," "injury risk," "contact sports." Studies were included if they investigated the effects of maximal cushioning footwear on lower limb biomechanics or examined biomechanical factors associated with ACL injuries in the context of footwear. Both experimental studies and relevant reviews were considered and not just limited to internal funding. Moreover, they had to be conducted in peer-reviewed published journals. Studies focusing solely on non-maximal footwear or not addressing biomechanical outcomes related to ACL injury risk were excluded.

3. Effects of maximal, traditional and minimal Cushioning Shoes on Running Biomechanics

Maximal cushioning shoes are designed with thicker midsoles and increased shock-absorbing materials. Studies have shown that these shoes can influence running biomechanics in several ways: such as; impact forces and loading rates: cushioning shoes may reduce peak vertical ground reaction forces and loading rates during running. However, some studies have reported inconsistent findings, with certain individuals exhibiting higher loading rates in maximal shoes. and; ankle and foot kinematics: Increased midsole thickness can alter ankle joint mechanics. Runners in maximal shoes may exhibit increased ankle dorsiflexion and changes in foot strike patterns. Finally; eversion mechanics: prolonged or increased eversion has been observed in runners using maximal cushioning shoes, which may affect the loading of the knee joint and surrounding structures.

Traditional cushion shoes, known for their traditional outlook and low or no cushion under the sole of the foot, are used daily by individuals. On the other hand, maximal and minimal cushion shoes have been recently advocated and proved to be beneficial for absorbing pressure and helping individuals to perform better while running. This benefit, however, in some cases is not without its costs. For example, it may higher the injury rate risk due to biomechanics alternation of the foot.

While changing stance into kinematic and kinetic, the reliability of the performer running depends heavily on one's background, but during the toe-off period, whether or not feeling comfortable is important for objectively describing ACL injuries. As such, studies so far investigating ACL injuries would not solely end in knee position, but rather osteoarthritis would be the underlying effect that can significantly lower the quality of life of individuals, whether actively by lowering daily range of movement and distance or consistent-continuous pain. Hence, although cushioned shoes can enhance individual performance while training for specific athletic objectives during periodization, they might also significantly affect one's life.

4. Biomechanical Factors Associated with ACL Injury Risk

Excessive knee valgus during landing or cutting maneuvers increases ACL strain; this can lead to making the knee unstable during agility-required movements, especially in power and sudden turns or in contact sports. However, individuals would not just get injured by performing in contact sports, and even during normal runs, valgus angle would cause harm; this can be solved by corrective exercise, more importantly shoes would play an important role in this regard and can play a vital role for both professional and individuals.

Forces on the other hand can be another stance to discuss biomechanical factors as such that cause the tibia to move forward relative to the femur can stress the ACL. Running biomechanics and force that imply in the either medial or lateral of the plantar while it touches the ground can be changed by both the biomechanical perspective of the lower limb, which is controllable mostly while running with shoes, and the impact of agonist-antagonist perspective of surrounding muscles.

Last but not the neglectable part is associated with altered hip and knee flexion angles, which can affect the distribution of forces across the knee joint. From a kinetic perspective, the right angle is disturbed due to how toe-off and heel, regardless of version and eversion, can impact both the economics of running and performing and ACL. While maximal cushioning shoes may reduce impact forces, their influence on biomechanical factors related to ACL injury is complex. In one study, Hannigan and Pollard (2020) they concluded that although the force of maximal cushioning might be significantly lower in the sole of the foot but in alternative, runners might be at more risk due to higher eversion [8].

5. Discussion and Conclusion

The literature suggests that maximal cushioning shoes can significantly alter running biomechanics for much higher comfort and enhancement in performance by lowering cost of running or walking, which may have implications for ACL injury risk. While the increased cushioning aims to reduce impact forces, the resultant changes in lower limb kinematics and kinetics may inadvertently increase stress on the ACL, and eventually put the performer at more risk of injury.

Alterations in ankle dorsiflexion and eversion mechanics can lead to compensatory movements at the knee, such as increased valgus angles and reduced knee flexion during loading. These biomechanical patterns are associated with higher ACL strain and injury risk.

In contact sports like American football and soccer, where cutting and pivoting movements are frequent, such as sudden return and even engaging in another athlete's force while chasing another direction, footwear that affects knee joint loading can influence injury rates. The shoe-surface interaction is critical, and maximal cushioning shoes may alter traction and stability during dynamic movements. Hence, it is safe to note the fact that previous injuries while getting prepared for competition are significant enough to prevent or help the body to maximize much better in performance perspective, which would lead to choosing the right shoes for the right momentum if one considers longer-safer results whether lifestyle or athletic perspective. Moreover, the potential reduction in proprioceptive feedback due to thick cushioning may impair an athlete's ability to execute precise movements, further increasing injury risk.

However, the relationship between maximal cushioning shoes and ACL injury risk is not straightforward, due to other cofounding factors, such as previous injuries, and biomechanical angle of body movement while performing. Individual differences in biomechanics, neuromuscular control, and adaptation to footwear can modulate these effects. Some athletes may benefit from the shock absorption provided by maximal shoes, while others completely otherwise may experience adverse biomechanical alterations.

Maximal cushioning shoes affect running biomechanics in ways that may influence ACL injury risk. While they may reduce impact forces, the alterations in lower limb kinematics and kinetics, particularly increased eversion and changes in knee mechanics, could potentially increase stress on the ACL. Athletes and clinicians should consider these factors when selecting footwear, especially for sports involving cutting and pivoting movements. Further research is needed to clarify the long-term effects of maximal cushioning shoes on ACL injury risk and to develop guidelines for their use in different athletic populations.

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