

The Potential Risks of Carbon Plated Running Shoes on Biomechanics

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Introduction

- Carbon Plated Running shoes have become very prominent across the running world^[8]
- Carbon plated shoes have been shown to reduce energy cost and improve Running economy (RE) when compared to non-carbon plated shoes^[4,5,11]
- The restricting of the Metatarsophalangeal (MTP) joint allows for propulsion by reducing negative work^[3,4,17]
- Longitudinal bending stiffness (LBS) restricting the MTP joint can increase the pressure felt by the MTP joint^[1,14]
- The restriction of the MTP joint can potentially increase the risk of bone stress related injuries^[6,10,14,15]
- MTP restriction can exacerbate body asymmetry while running^[2,5,7]

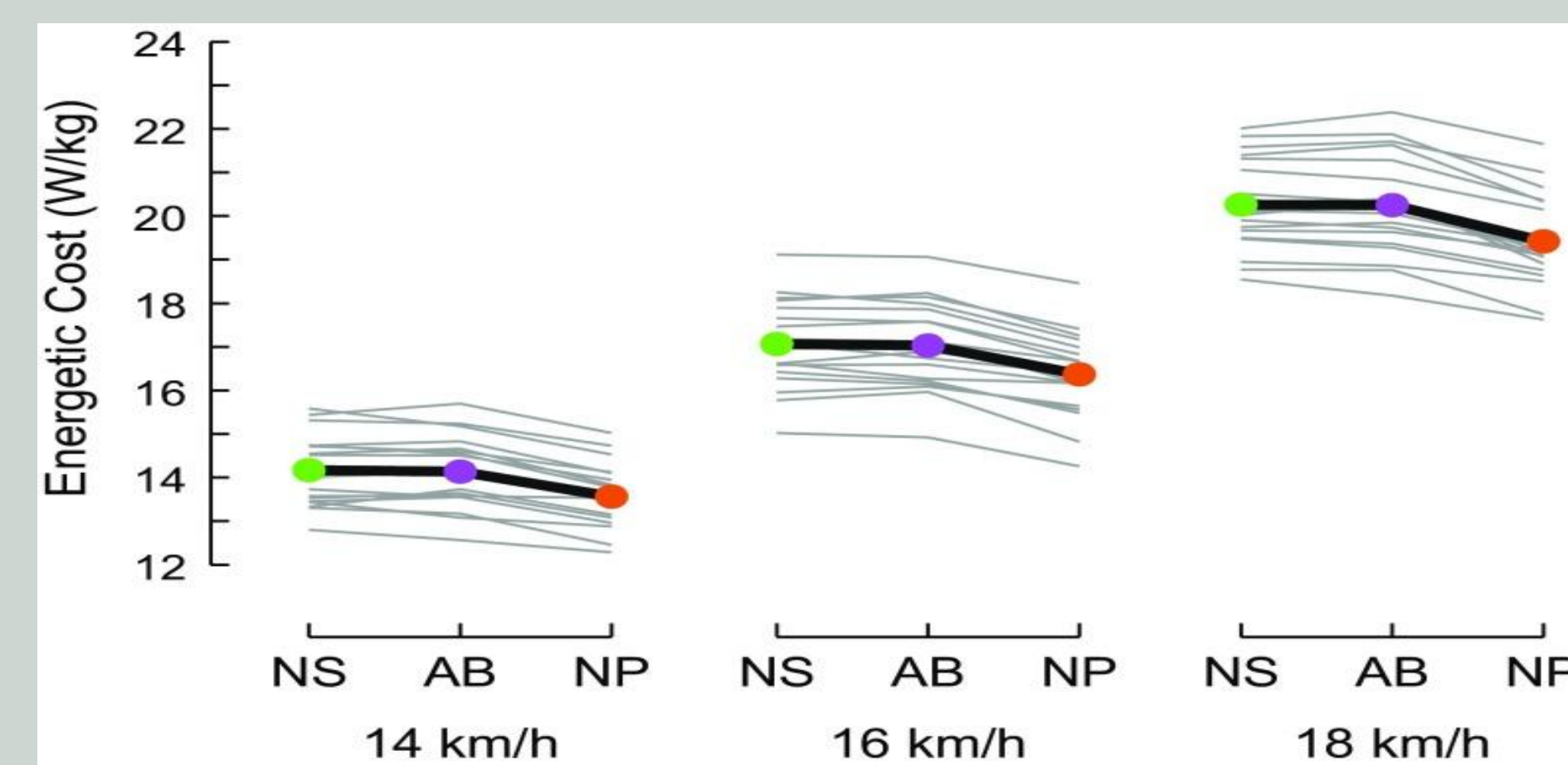


Figure 1. Graph depicting Energy Cost (W/kg) for a CPRS compared to non-CPRS^[4]

Methods

- Google Scholar and ResearchGate were used to find articles
- The Bibliographies of several articles were used to find additional articles
- Two additional articles were requested from ResearchGate
- Key Words Included: Carbon plated running shoes, Injury, Metatarsophalangeal Flexion, Longitudinal Bending Stiffness, Forefoot foot strike, Fatigue

References



Carbon Plate Design on Running Economy

- Plate stiffness (High vs low LBS) and curvature (Flat vs curved) play an impact on RE benefit^[9,11,12]
- Moderate LBS plate designs reduce energy cost compared to low and high LBS designs^[11]
- There is a critical point in which increased plate stiffness negatively impacts RE^[9,11]
- Low curvature plate design significantly improve RE compared to high curvature plates^[12]
- High curvature plates have less impact on lower body kinematics compared to flat plates^[16]

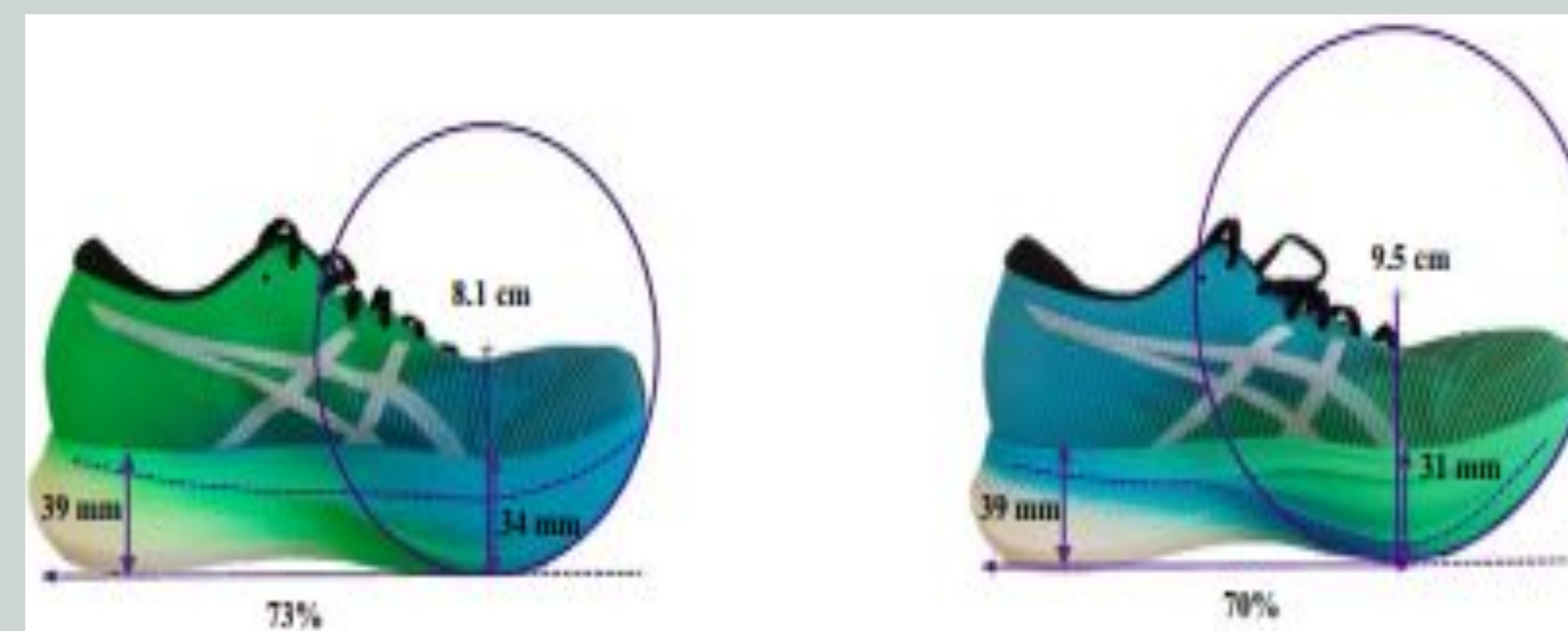


Figure 2. Commercially available low and high curvature CPRS models^[12]

Effects of Metatarsophalangeal Flexion

- Restricting the MTP joint increases the amount of stress felt on the joint^[1,14]
- High LBS footwear increased the stress felt by the second metatarsal compared to low LBS footwear^[1]
- Case studies show that the navicular bone is susceptible to stress injuries when transitioning to CPRS from traditional footwear^[10,15]

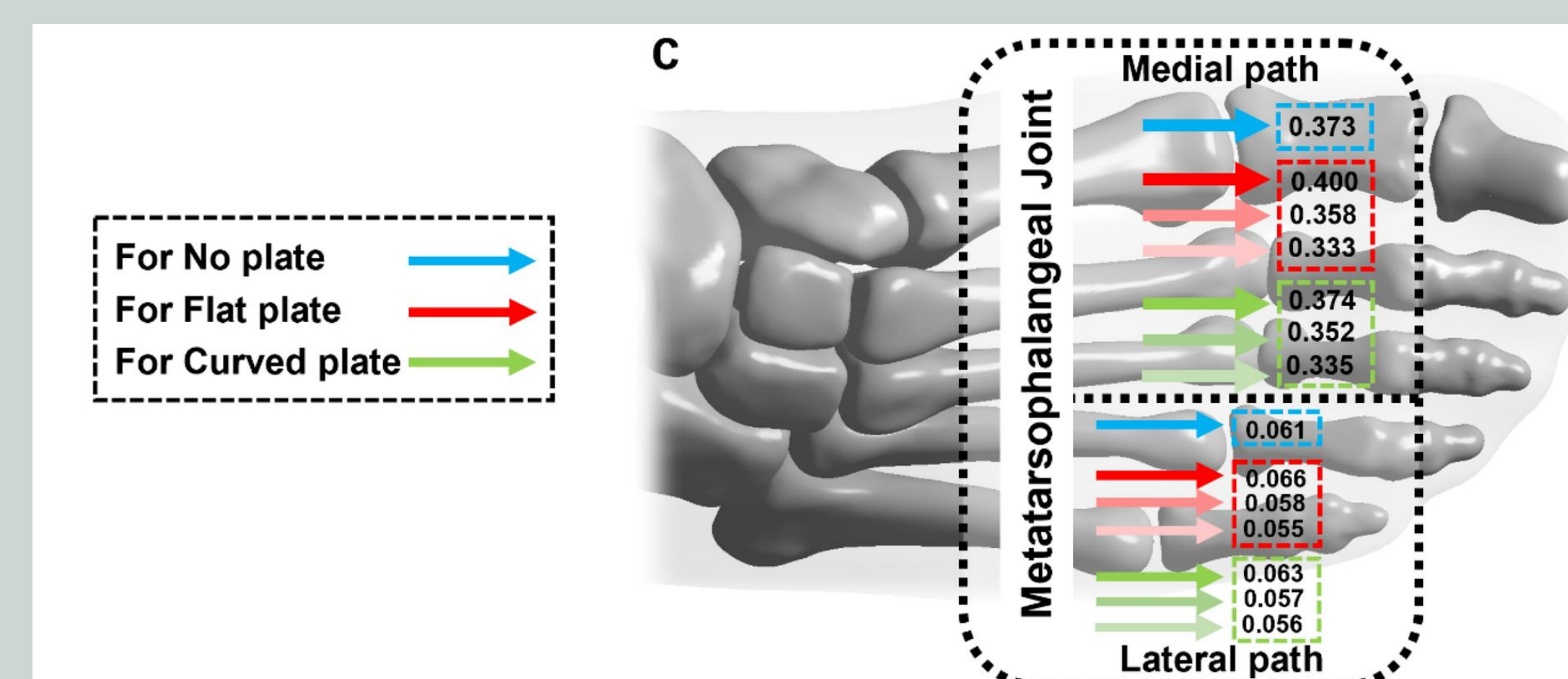


Figure 3. Model depicting force transmission across the foot in differing plate conditions^[14]

Carbon Plates and Fatigued States

- Distal restriction proximal compensation occurs from the restriction of the MTP joint caused by high LBS footwear^[7,13]
- Restriction in MTP and Ankle joints lead to compensation by hip and knee joints^[7,13,16]
- Bilateral asymmetries are exacerbated from increased footwear stiffness similar to that of fatigued conditions^[2,6,7]
- Flat plate designs cause more compensatory movements, compared to curved designs, which may increase injury risk^[16]

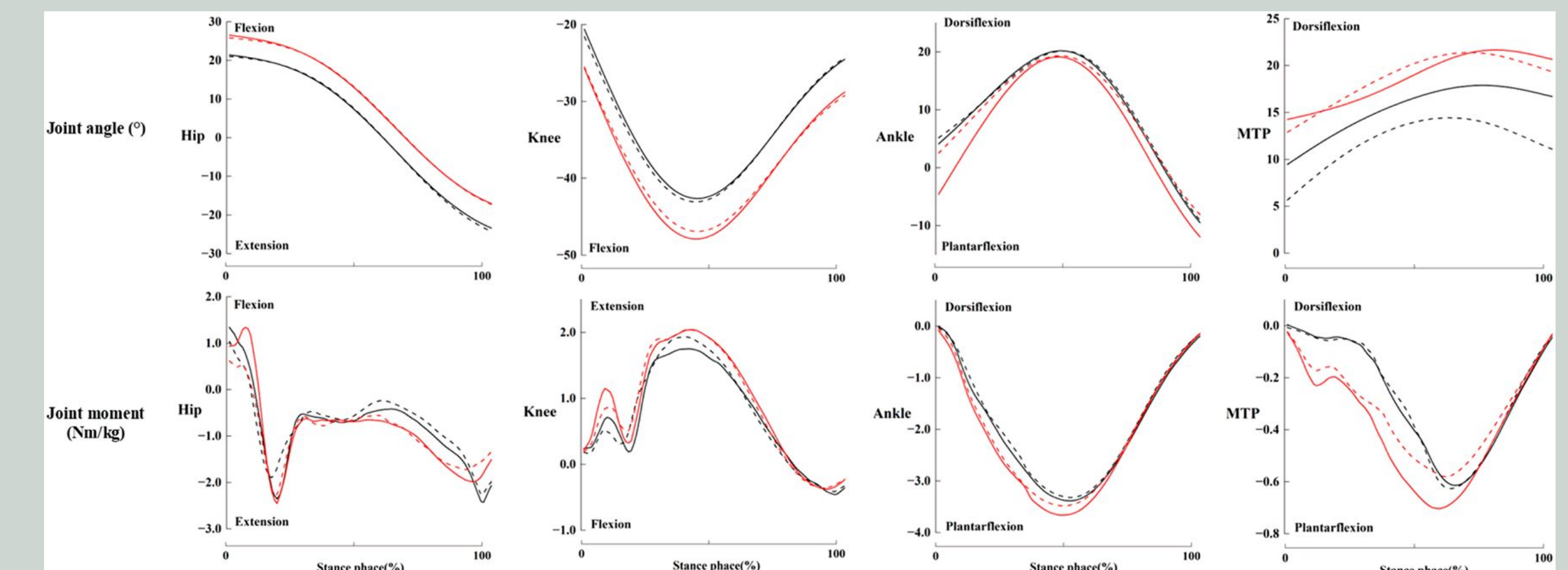


Figure 4. Graphs depicting changes in joint angle and joint momentum for non-fatigued and fatigued states. Red = Flat. Black = Curved. Solid = PRE. Dotted = Post^[16]

Conclusion

- Flat plate designs reduce RE more than curved design^[12]
- Curved plates reduce the amount of pressure felt by the MTP joint^[14,16]
- The increased pressure on the MTP can increase the risk of bone stress injuries^[1,10,14,15]
- Bilateral asymmetries in fatigued states are further exacerbated by CPRS which can pose injury risk^[6,7,13,16]

Further Research

- A comprehensive longitudinal study is needed to understand long term usage effects
- Limited use of EMG and muscle morphology
- Potential impact on tactile sensation and proprioception
- Potential differences in casual vs elite from long term usage