HIGHER VERTICAL STIFFNESS IS RELATED TO GREATER FIFTH METATARSAL BONE MINERAL DENSITY IN FOOTBALL PLAYERS

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INTRODUCTION

• Multi-directional sport athletes are prone to lower extremity stress fractures, particularly in the 2nd and 5th metatarsals. (Kahn 2017)
• Lower extremity stiffness (the relationship between the deformation of the lower body and a given force) may influence injury risk. (Butler 2003)
• Higher lower-extremity stiffness may improve athletic performance, enhance overall joint stability and shield the ligaments from deleterious loading during athletic activities. (Waxman 2018)
• However, too much stiffness may increase the risk for bony injury due to increased forces that must be attenuated by the skeletal system.
• In theory, according to Wolff’s Law, individuals with high stiffness would adapt with higher bone mineral density (BMD).

PURPOSE

• To identify differences in BMD between athletes with relatively higher and lower levels of vertical stiffness ($K_{Vert}$).

METHODS

Participants

• 41 male American football players (age: 16.1±1.4 yrs, height: 176.5±6.8 cm, mass: 80.6±18.3 kg)

Procedures

• Vertical stiffness ($K_{Vert}$) of the dominant leg was assessed via repetitive single-leg vertical hopping (2.2 Hz) (Figure 1).
• Participants were divided into tertiles based on their body mass normalized $K_{Vert}$ values.

METHODS (cont.)

• BMD of the whole body (BMD$_{WB}$), dominant limb (BMD$_{DL}$) and second and fifth metatarsals (BMD$_{Met2}$ and BMD$_{Met5}$, respectively) of the dominant leg were measured from separate scans using dual-energy x-ray absorptiometry (Hologic QDR) (Figure 2)
• In the metatarsal scans, the bone of interest was outlined at the points of greatest contrast.
• BMD was calculated as the bone mineral content in the outlined region divided by the area outlined. (Pritchard 2017)

Data Analysis

• Independent t-test were utilized to determine differences in BMD between high- and low-stiffness tertiles.

RESULTS

• No significant differences were identified in age, height, or body mass between tertile groups ($p>0.05$)
• Participants in the high stiffness tertile had significantly greater $K_{Vert}$ than the low stiffness tertile ($p<0.001$).
• High-stiffness tertile = 0.28±0.01 kN·m/kg
• Low-stiffness tertile = 0.20±0.02 kN·m/kg
• There was greater BMD$_{Met5}$ in the high stiffness group compared to the low stiffness group (0.34±0.11 g/cm$^2$, $p=0.029$) (Figure 3)
• High-stiffness tertile = 0.44±0.11 g/cm$^2$
• Low-stiffness tertile = 0.34±0.11 g/cm$^2$
• No significant differences ($p>0.05$) were identified between groups in:
  • BMD$_{WB}$, BMD$_{DL}$, BMD$_{Met2}$

SUMMARY AND CONCLUSIONS

• Football players greater levels of vertical stiffness were found to have significantly higher bone mineral density in the fifth metatarsal than players with lower levels of vertical stiffness.
• Thus, relatively higher stiffness may impose stress on the bone that results in favorable adaptation (increased bone mineral density).
• Continued work investigating the relationship between vertical hopping stiffness, bone mineral density, and training load may elucidate the risk of bony injury in these athletes is warranted.

REFERENCES