CONGDON SCHOOL OF HEALTH SCIENCES

DEPARTMENT OF PHYSICAL THERAPY

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

THOMAS J. HOCKENJOS*, KEVIN R. FORD§, JUSTIN P. WAXMAN *, ANH-DUNG NGUYEN‡, AUDREY E. WESTBROOK§, MICHELLE A. AUBE*, JEFFREY B. TAYLOR§

*HIGH POINT UNIVERSITY, CONGDON SCHOOL OF HEALTH SCIENCES, DEPARTMENT OF EXERCISE SCIENCE, HIGH POINT, NC
§HIGH POINT UNIVERSITY,CONGDON SCHOOL OF HEALTH SCIENCES, DEPARTMENT OF PHYSICAL THERAPY, HIGH POINT, NC
‡HIGH POINT UNIVERSITY, CONGDON SCHOOL OF HEALTH SCIENCES, DEPARTMENT OF ATHLETIC TRAINING, HIGH POINT, NC

hbapl Human Biomechanics & Physiology LABORATORY

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

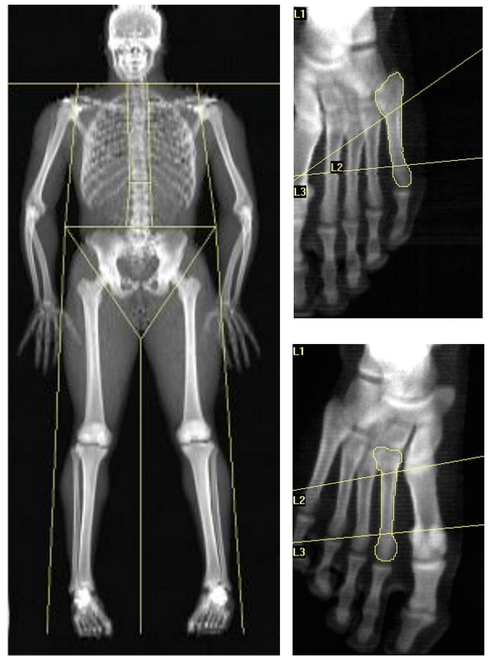
- 41 male American football players (age: 16.1±1.4 yrs, height: 176.5±6.8 cm, mass: 80.6±18.3 kg)

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.

Figure 1. K_{Vert} task.

METHODS (cont.)



Procedures

- 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.

Figure 2. Dual-energy x-ray absorptiometry images of whole body, second metatarsal and fifth metatarsal

RESULTS

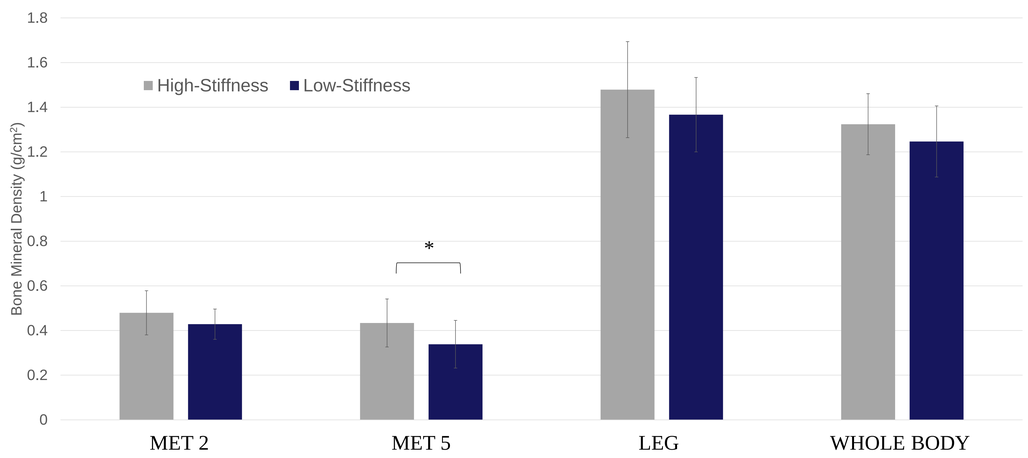


Figure 3. Bone mineral density levels in high- and low-stiffness tertiles. * p<0.05

RESULTS (cont.)

- 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^{-1}kg^{-1}
  - Low-stiffness tertile = 0.20±0.02 kN·m^{-1}·kg^{-1}
- 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

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