Gender Differences in Dynamic Loading in Elite Athletes: Implications for Risk Assessment and Injury Prevention

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Our disclosure is in the Final AOFAS Mobile App
We have no potential conflicts with this presentation
Introduction

• Review of our Division I institution’s injury database reveals that 27% of all musculoskeletal injuries in athletes are foot/ankle injuries.

• There appears to be a higher injury rate among female athletes than male athletes, particularly for bone stress injury rates in the foot/ankle.

• While some gender-specific risk factors have been reported, little is known about how dynamic loading of the foot during sports activities differs between men and women.
Study Aims

• Characterize the dynamic loading patterns at 11 subregions of the foot in healthy elite athletes.
• Compare dynamic loading patterns in male athletes with those of female athletes.
• Relate gender-specific loading differences during sports activities to known epidemiologic data on common locations of stress injuries in the foot.
Methods and Recruitment

• We recruited 106 healthy varsity athletes (89 male, 17 female)
  – Male
    • 39 Football, 15 Soccer, 12 Basketball, 8 Track, 2 Golf, 2 Volleyball, 1 Lacrosse, 1 Rugby
  – Female
    • 9 Soccer, 7 Track, 1 Field Hockey

• Subjects completed a course of standard athletic activities
  – 1.34 m/s treadmill walk
  – 2.91 m/s treadmill run
  – 2-footed jumping with required 2-footed landing
  – 10m shuttle run to simulate quick reversals of direction
  – 15m zig-zag course to simulate cutting at 45 degrees at speed
Methods and Recruitment

• Data collected via Novel Pedar wireless insole system.
• Variables measured included contact area, maximum force, peak pressure and maximum mean pressure.
• Force and pressure data were normalized to body weight. Averages between left and right foot were calculated for each variable and each foot region.
• Paired t-tests were performed for gender group comparisons.
Results

- Males showed a significantly \((p < 0.05)\) greater total contact area compared to female athletes.
- Males demonstrated higher maximum force at the base of the fifth metatarsal.
  - 47% greater maximum force while jump-landing
  - 47% greater maximum force while jump-takeoff
  - 27% greater maximum force during running
  - 23% greater maximum force during cutting
- Female athletes showed greater pressures in the medial forefoot than male athletes.
  - 44% greater peak pressure while running
  - 48% greater maximum mean pressure while running
  - 29% greater peak pressure while cutting
  - 44% greater maximum mean pressure while cutting
Results

Lateral Forefoot Loading

BW Adjusted Maximum Force

- Jump-Landing
- Jump Takeoff
- Running
- Cutting

Female
Male
Results

Medial Forefoot Loading

BW Adjusted Pressures (kPa/N)

- Female
- Male

Running PP
Running MPP
Cutting PP
Cutting MPP
Conclusions

• Body-mass adjusted dynamic loading patterns differ significantly between genders during sports activities, particularly in the forefoot.

• Differences coincide with locations of common stress injuries to the foot, supporting significant biomechanical contribution.

• Awareness of gender-aware modifications to footwear and training regimen may be beneficial to prevent bone stress injuries.
Conclusions

• Our institutions comprehensive injury database provides a unique tool to preemptively identify risk factors of injury rates.

• Further expansion of our dynamic loading database will help elucidate specific dynamic loading trends in athletes suffering common injuries to the foot and ankle.
References


