Abstract

The sex disparity in the incidence of noncontact anterior cruciate ligament (ACL) injuries among team-sport athletes has been well documented, with adolescent and older female team-sport athletes 4 to 6 times more likely to sustain an ACL injury compared with their equivalently-trained male counterparts. By contrast, dance has been shown to have a much lower ACL injury rate when compared with team sports [0.07-0.31 ACL injuries per 1000 exposures] across all 3 foci of ligament dominance—ligament, vastus lateralis and hamstring [semimembranosus] muscles [Noraxon, 250 Hz]. Several neuromuscular deficit theories have been proposed to explain the sex disparity in ACL injury rates, including: ligament dominance [excessive reliance on ligaments to absorb landing forces]; quadriceps dominance [preferential use of quadriceps to stabilize the knee adduction moment]; trunk dominance [inability to control or stabilize the position of the trunk]; and leg dominance [side-side asymmetries].

Purpose: To compare dancers’ and team athletes’ resistance to fatigue and the biomechanics of a jump landing task before and after achieving fatigue relative to the risk variables associated with ligament dominance, quadriceps dominance, and trunk dominance theories. We hypothesized that female dancers would perform a drop landing task without demonstrating typical sex-related risk factors associated with an ACL injury exemplified by a lower peak knee valgus angle and shorter trunk lean compared to male athletes. Female dancers would likely exhibit greater knee flexion angle, hip adduction moment, and trunk lateral flexion than team sport athletes. These findings may be related to the lower ACL injury rate that female dancers experience compared with female team sport athletes and the lack of sex disparity in ACL injury rates among men. 

Introduction

In executing a 30-cm drop landing, female athletes displayed greater knee valgus angle, hip adduction moment, and trunk lateral flexion 

Materials and Methods

Subjects:

Twenty male and female professional female dancers and twenty male and female collegiate athletes performed single-leg landings from a 30 cm platform before and after a lower extremity fatigue protocol.

Inclusion Criteria:

• Male and female college athletes
• No history of surgery on the lower extremities
• Number of sets recorded; subjective rating of fatigue at end using Borg CR-10 scale
• Repeat until a 10% decrease in maximum vertical jump height is achieved

Ligament Dominance Group x sex interaction [P=0.039]

- Female dancers have a higher peak knee valgus angle than other 3 groups [P=0.001]
- Female dancers have lower peak hip adduction moment than 1 of the other 3 groups [P=0.003]

Main effect of fatigue [P=0.001]

• Increased the peak knee valgus moment [P=0.047]
• Decreased the peak hip adduction moment [P=0.044]
• Increased the hip external rotation angle [at initial contact and peak; P=0.001 and P=0.002, respectively]

Results

Trunk Dominance:

- Male dancers landed with a lower peak trunk flexion, lower lateral trunk lean than did team-sport athletes
- Main effect of fatigue [P=0.001]
  Peak forward trunk flexion, lateral trunk lean increased

Discussion and Conclusions

Female dancers do not exhibit several neuromuscular deficits that are evident in female team sport athletes and that predispose them to ACL injuries. They exhibited similar biomechanical profiles to the male dancers and landed with a significantly higher peak knee valgus angle, hip adduction moment, and trunk lateral flexion than female team sport athletes. These findings may be related to the lower ACL injury rate that female dancers experience compared with female team sport athletes and the lack of sex disparity in ACL injury rates among men. 

Fatigue had a significant effect on biomechanical variables across at 3 foci of analysis, although there were no significant differences in biomechanical responses to fatigue among the different test groups. However, decreased trunk flexion significantly longer to reach a similar [objective and subjective] state of fatigue than did team athletes, suggesting that future research examine fatigue resistance as a potential explanation for differences in ACL injury rates between team athletes and dancers.

References

1 Hagins SC, Hagins CL, Marshall H, Sharon G, VanDenBerg M, et al. A COMPARISON OF LANDING MECHANICS BETWEEN DANCERS AND TEAM-SPORT ATHLETES. Jan I Kremenich, MEng1, Marshall Hagins, PhD2, Marjanneke Liederbach, PhD3 Karl F Orishimo, MS1, Evangelos Pappas, PhD2

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Facet of Fatigue

Main effect of fatigue

P = 0.001

Female athletes

Female dancers

Male athletes

Male dancers

Lateral Trunk Lean

Hip Add Moment

Knee Valgus

Subjects

Male athletes

Female athletes

Male dancers

Female dancers

Main effect of fatigue

- Increased the peak knee valgus moment [P=0.047]
- Decreased the peak hip adduction moment [P=0.044]
- Increased the hip external rotation angle [at initial contact and peak; P=0.001 and P=0.002, respectively]

Main effect of group

- Main effect of group [P<0.001]
- Female dancers do not exhibit several neuromuscular deficits that are evident in female team sport athletes and that predispose them to ACL injuries. They exhibited similar biomechanical profiles to the male dancers and landed with a significantly higher peak knee valgus angle, hip adduction moment, and trunk lateral flexion than female team sport athletes. These findings may be related to the lower ACL injury rate that female dancers experience compared with female team sport athletes and the lack of sex disparity in ACL injury rates among men. 

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