GENDER DIFFERENCES IN FRONTAL PLANE LOWER EXTREMITY KINETIC VARIABILITY DURING LANDING

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INTRODUCTION & PURPOSE

Investigations of human movement variability have been used as a means of exploring neuromotor functioning, where performance variability is thought to provide the system with flexibility and a mechanism for adaptation to movement repetition [1,2,4,6]. Operationally, variability has been considered to fall within optimal limits (Figure 1), while excessively high or low variability has been implicated in injury susceptibility [1,2,4,6]. Landing has been explored due to a high incidence of injury in athletic performance, as well as the ability to easily control task demands through increases in landing height [3,4].

The purpose of this investigation was to evaluate changes in lower extremity kinetic variability in the frontal plane, exploring gender comparisons during landing. Peak frontal plane joint moments were used to access variability across landing heights at the hip, knee, and ankle joints. Landing height was increased as a proportion of maximum vertical jump height (MVJH), which characterized lower extremity functioning across a range of task demands.

METHODS

Fourteen participants (7 male, 7 female; mean age 22.6±3.4 years; height 1.71±0.10m; mass 67.5±10.3kg) free from previous lower extremity injury were examined. Informed consent was obtained prior to participation as approved by the Research Ethics Board at the affiliated institution.

Kinematic and kinetic data were simultaneously acquired using a 12-camera system (Vicon MX T40-S; 200Hz), 35-point spatial model (Vicon Plug-in Gait Fullbody), and two synchronized force platforms (Kistler 9281CA, 9281B; 2000Hz). Data filtering and interpolation included a low pass, 4th order Butterworth filter (cutoff 50Hz) and cubic (3rd order) spline. Ground contact was identified from force platform data (vertical ground reaction force >25N). Landing phase was defined from ground contact to the point vertical center of mass (COM) velocity was zero (Figure 2). Peak frontal plane moments were calculated at each lower extremity joint (hip, knee, ankle) across the landing phase.

Participants completed a general warm up prior to testing. Five maximum vertical jump trials, measured using a Vertec, were averaged to determine maximum vertical jump height (MVJH). Five step-off bilateral landing trials were completed at four successive drop heights, calculated as a percentage of maximum vertical jump height (MVJH). Five step-off bilateral landing trials, measured using a Vertec, were averaged to determine

RESULTS

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Participants completed a general warm up prior to testing. Five maximum vertical jump trials, measured using a Vertec, were averaged to determine maximum vertical jump height (MVJH). Five step-off bilateral landing trials were completed at four successive drop heights, calculated as a percentage of maximum MVJH (60%, 100%, 140%, 180%). Landing heights were ordered from lowest to highest to minimize risk of injury. Participants were instructed to land with both feet simultaneously, one foot on each force platform.

Variability was expressed using coefficient of variation (CV%). Comparisons were made using 2x3x4 (Gender x Joint x Height) mixed model ANOVAs, with repeated measures on height (α=0.05), for each dependent variable using SPSS 20.0 for Mac.

DISCUSSION

Differences in frontal plane lower extremity peak moment variability were detected among landing heights, lower extremity joints, and between genders. A significant main effect for lower extremity joint (F2,78)=7.771, p<.001, η2=.166) showed lesser variability at the knee joint (16.9±4.5%) relative to the hip and ankle joints (23.8±5.2%, p<.001; Figure 3). This suggests freezing at the knee joint during landing, which may have implications for injury susceptibility [1,2,4,6].

Females demonstrated greater overall lower extremity peak moment variability than males (23.8±5.2%, 19.7±4.5%), respectively in the frontal plane (F1,76)=16.126, p<.015, η2=.073). Significant interaction was observed between landing height and gender (F2,48,175.327)=7.158, p<.001, η2=.084), suggesting that males and females differed in peak lower extremity moment variability across landing heights. As a result, simple main effects analyses were carried out.

Independent samples t-tests between genders identified lower extremity variability differences at the 60% MVJH landing height (653.76±4.753, p<.001; Figure 4). From this, it appears that females responded differently to the landing task compared to males, where landing heights at, and in excess of 100% MVJH resulted in a significant decrease in peak lower extremity joint moment variability for females (F2,125.82,680)=6.629, p=.002; η2=.146; Figure 4).

The lack of significant differences across landing heights for males (F1,424.55,539)=3.210, p=.060, η2=.076; Figure 4) suggests that male participants maintained a relatively constant level of lower extremity kinetic variability during landing, while females adopted a new landing strategy in excess of 100% MVJH. This may provide insight into gender differences in susceptibility to injury, particularly at increased landing heights [4]. These findings also suggest that females demonstrate greater lower extremity movement variability, working within operational limits that differ from males at lower task demands [8]. This may be a product of joint laxity relative to males, which may be associated with increased risk of lower extremity injury during landing [1,2,4,6].

CONCLUSIONS

Overall, females demonstrated greater lower extremity kinetic joint variability during landing compared to males, but showed significant decreases when landing in excess of 100% MVJH. Future research should explore a wider range of task demands, seeking to better understand the relationship between movement variability and movement control, with attention to gender comparisons. Lesser kinetic variability at the knee may also shed light into the high rates of injury at this joint, providing avenues for future research.

REFERENCES