EFFECT OF FATIGUE AND SEX ON THE PERFORMANCE-INJURY CONFLICT DURING CLEATED CUTTING

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Summary

Performance-injury conflicts occur when movement strategies which improve performance also increase injury risk. Such conflicts have been identified in studies examining cutting task performance in non-fatigued male athletes wearing court shoes [1,2]. The current study investigates the effects of fatigue and sex on cutting task performance-injury conflicts under cleated conditions. No significant effects of fatigue or sex were found. While peak knee valgus moments were 3x higher than previously reported [1], no performance-injury conflicts were found.

Introduction

Dynamic control of the center of mass (CoM) is necessary for successful change-of-direction. However, previous work has found performance-injury conflicts with commonly performed cutting strategies [1,2]. Movement strategies correlated with successful cutting-task outcomes have also been correlated with greater external knee abduction moments (KAM). High KAM values have been linked to increased anterior cruciate ligament injury incidence [1,2,3]. This study investigates the influence of fatigue and sex on performance-injury conflicts during cleated cutting maneuvers.

Methods

College-aged soccer athletes (10M/10F) performed cutting tasks in cleats (adidas Predator .2) on an indoor turf surface. A 19-camera system (Vicon, 100 Hz) and four force platforms (AMTI, 1000 Hz) were used to collect marker displacement and ground reaction force data. An inverse dynamics model was used to calculate joint kinematics and kinetics. Athletes performed six cuts (targeting 80% max speed to unanticipated cut) before and after a multi-stage running fatigue protocol.

Two dynamic stability movement strategies were quantified: medial-lateral (M-L) foot placement at touchdown (TD) and M-L center of pressure (CoP) distance from the 5th metatarsal [1]. These movement strategies were regressed against two metrics of cutting performance (avg. M-L CoM acceleration and change of direction angle during stance) and one metric of injury risk (peak KAM during weight acceptance). Two-way mixed model ANOVAs were used to evaluate the effects of sex and fatigue on each metric. Benjamini-Hochberg p-value adjustments were performed.

Results and Discussion

While most cutting metrics were similar to those previously reported, peak KAM was higher in the current study by a factor of three (Table 1).

Table 1: Summary of cutting task metrics. TD = touchdown.

Performance outcomes and dynamic stability variables	Hugard et al.	Sankey et al. [1]
Change of direction angle (°)	20.4±3.90	20.6±3.20
Avg. M-L CoM accel. (m/s^2)	2.59±0.45	4.91±0.91
Peak KAM (Nm/kg)	1.28±0.49	0.44±0.25
M-L Foot placement at TD (m)	0.43±0.08	0.43±0.06
M-L CoP pos., 90% stance (cm)	3.95±1.26	4.80±1.25

No significant effects of sex or fatigue were detected. Multiple linear regression indicated significant relationships between M-L CoP and all performance outcomes but no correlations between foot placement and performance outcomes (Table 2).

Conclusions

Contrary to previous work, results indicated no performance-injury conflicts in the movement strategies and performance outcomes investigated. M-L CoP was negatively correlated with successful performance metrics and positively correlated with peak KAM. These results indicate that a lateral CoP position during late stance is correlated with improved cutting performance and reduced injury risk. The increased KAM in the current study may be the result of using cleated footwear on a turf surface, highlighting the importance of using game-specific footwear and surfaces when investigating cutting metrics.

Acknowledgments

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References

[1] Sankey et al. (2020). *J. of Biomechanics*, **104**: 109711
[2] Dos'Santos et al. (2021). *Sports Medicine*, **51:**1983–1998
[3] Kristianslund et al. (2014). *Br J Sports Med*, **48**: 779-83

Table 2: Summary of multiple linear regression analyses. '*' indicates adjusted p-value < 0.05. Direction of significant relationships: '-ve' = negative relationship, '+ve' = positive relationship. TD = touchdown, TO = toe-off.

	Performance outcomes: Cutting task success and injury variables		
Dynamic stability movement strategy variables	Average M-L CoM Acceleration (TD-TO)	Change of direction angle (TD-TO)	Peak KAM (weight acceptance phase)
M-L Foot placement at TD	p > 0.05	p > 0.05	p > 0.05
M-L CoP position at 90% stance	p = 0.017* (-ve)	p = 0.027* (-ve)	p = 0.017* (+ve)