INTERPERSONAL COORDINATION BETWEEN FEMALE SOCCER PLAYERS: LEADER-FOLLOWER ROLES

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Context: Football is characterized by high-intensity movements, coordinated action between teammates, antagonistic action with opponents, and repetitive behavior. These attributes contribute to majority (60-90%) lower extremity injuries through non-contact mechanisms, primarily hamstring strains, anterior cruciate ligament (ACL) tears, and ankle sprains.(1) Once an individual experiences injury, they are increased risk for future injury. One reason for this is inadequate screening of readiness for sport.(2,3) Specifically, there is growing concern towards the construct validity of return to sport test batteries, as it is evident that highly controlled uniplanar assessments (e.g., hop tests) fail to recreate the complex sport environment or elicit comparable behavioral demands.(2) Return to sport assessments that incorporate on-field dynamics may better screen patients' readiness for chaotic sport-like environments.(3) We investigated whether previous injury influences female soccer players' interpersonal dynamics during a collision avoidance task. Methods: We paired eighteen female athletes, nine with history of lower extremity injuries and nine without, into dyads. Each completed 20 trials of an externally paced collision-avoidance agility task with an unanticipated change of direction (e.g., perturbation). We digitized participants using high-speed motion capture and analyzed their center of mass trajectories using cross-recurrence quantification analysis (CRQA), a non-linear analysis of the time series. Figure 1 provides an overview of these methods. To determine emergent leader and follower roles within each dyad, we used diagonal-wise cross-recurrence. Leader-follower status was then used to study the strength and stability of dyadic dynamics across task stages (early, perturbation and late), using CRQA determinism (DET) and laminarity (LAM) respectively. To determine group and stage effects, we applied linear mixed effect models with trials as random factors. Further, we tested the influence of self-reported knee functioning, fear of movement, fear of injury, and risk-taking propensity on leader-follower status using logistic regression. Results: All dyads demonstrated a high DET throughout all trials (=90%), indicating highly stable, coordinated behavior. The healthy control participant was the leader 65% of all trials and led most trials in 7 of 9 dyads. Perturbation temporarily disrupted coordination strength (DET: $R2 = 0.65$, $p < 0.001$) and stability (LAM: $R2 = 0.71$, $p < 0.001$) for all dyads regardless of leader-follower dynamics. However, when individuals with history of lower extremity injury were in the follower role, they failed to restore the strength of this coordination in the late stage compared to control participants ($d = 0.39$ [0.02, 0.76]), indicating weaker coupling after the perturbation when following the control participant's actions. Figure 2 presents these results. Logistic regression failed to identify demographic or psychological metrics that influenced leader-follower dynamics. Conclusion: Participants successfully coordinated behavior during a collision-avoidance agility task and coordination stability was negatively affected by an external perturbation. Our results suggest that individuals with a history of lower extremity injury may have a diminished ability to adapt interpersonal coordination to perturbation, as they retained coordination stability with weaker coupling compared to controls. Although speculative, diminished ability to recover strong coordinated behavior following an unanticipated stimulus may

contribute to higher risk of re-injury seen in those with previous lower extremity injury.

References

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