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Ph.D. DISSERTATION DEFENSE

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Title: Leveraging Linear and Angular Momenta Analyses to Understand Control and Performance of Sporting Movements
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ABSTRACT

Successful execution of dynamic whole-body sporting movements requires the regulation of whole-body linear and angular momenta. The strategies through which the requirements of momenta regulation are satisfied provide foundational insights that inform research on athlete performance and injuries. In this dissertation, I studied fastball pitching in baseball and two-foot running jumps (TFRJs) in basketball to understand how the athletes regulated the body's linear and angular momenta and how momenta generation and regulation relate to performance in a variety of contexts. In baseball pitching, the back and front legs had different responsibilities of whole-body linear and angular momenta and achieved those objectives using different mechanisms. Angular momentum about the body's COM was generated and transferred from the lower limbs into the trunk and pitching arm, which helped increase the linear momentum of the pitching arm segments near the time of ball release. Additionally, the maximum whole-body angular momentum about the leftward axis and trunk angular momentum about the leftward and upward axis had significant positive associations with ball speed. In basketball TFRJs without a ball, the first leg to contact the ground generated significantly more upward impulse than the second leg, at the group level. There were more differences across participants in the patterns of backward impulse generation, highlighting multiple viable strategies. When compared to TFRJs without a ball, TFRJs with a ball had lower jump heights in most participants which were explained by more initial downward COM velocity and/or lower net upward impulse generation using participant-level analyses, and some participants had no differences in jump height. In both TFRJs with and without a ball, higher jump heights correlated with a faster running approach, more forward initial foot placement, and a longer COM ascent distance alongside more net backward and upward impulses. Lastly, joint kinetics during TFRJs with and without a ball were explored and characterized. Overall, this dissertation clarified the strategies of momentum generation and regulation during TFRJs in basketball and baseball pitching, analyzed how momentum-related variables relate to task performance, and highlighted the multiple viable movement strategies used by different participants to fulfill the needs of the task.