Kinematic Analysis of the Lower Limbs and Trunk of Nonexercisers during Forward Lunges

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Objective: This study aimed to compare and analyze the lower limb and trunk kinematics during the forward lunge between non-exercisers and exercisers, thereby identifying movement characteristics specific to non-exercisers. Methods: Three- dimensional kinematic data were collected using a motion capture system (240 Hz) with 17 inertial measurement units (IMUs) from 11 non-exercisers and 13 exercisers. Joint angles at the hip, knee, and ankle joints, segmental inclination angles, and trunk inclination angles were calculated. Dynamic differences throughout the entire lunge cycle were compared using statistical parametric mapping (SPM). Results: Compared to habitual exercisers, non-exercisers had significantly shorter step length ($p=0.033$) and significantly slower peak center of mass velocity (forward: $p=0.005$, backward: $p=0.016$). Additionally, hip extension in the supporting leg was significantly smaller ($p<0.001$), accompanied by significantly smaller peak flexion angles in the forward leg's hip ($p=0.022$), knee ($p=0.036$), and ankle ($p=0.001$) joints. The trunk exhibited significantly greater posterior tilt during the initiation phase (0% – 16.3%, $p=0.040$) and completion phase (92.5% – 100%, $p=0.048$) of the movement in non-exercisers. Conclusion: The lunge movement in non-exercisers is characterized by insufficient propulsive force due to restricted hip extension in the supporting leg and the resulting reduced load on the leading leg. Furthermore, the trunk posterior tilt observed during the initiation and completion phases may reflect a lack of dynamic balance and weakened trunk muscles, warranting attention from an injury risk perspective.From the perspective of knowledge science, this study is significant in that it quantitatively demonstrated the movement characteristics during the lunge in non-exercisers, thereby contributing to the establishment of objective evaluation criteria for physical movements.

Keywords: Lunge, Lower Limb, Trunk, Kinematics, Exercise, Statistical Parametric Mapping