
Performance on the Timed Single-Leg Step-down Test is correlated with Hip and Knee Biomechanics as Measured by 3D Markerless Motion Capture

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ABSTRACT

Introduction: The timed single-leg step-down (SLSD) test is widely used in clinical and sports settings to assess lower extremity function and injury risk, yet the specific biomechanical determinants of performance on this test remain poorly understood. The purpose of this study is to investigate the relationship between performance on the timed SLSD test and hip and knee biomechanics captured by a markerless 3-D motion-analysis system. **Methods:** Twenty (20) healthy high school athletes with no recent history of lower extremity injury completed a 60-second timed single leg step down test. The number of quality SLSD repetitions (REPS) constituted their SLSD score. Their movements were captured by a 3D motion capture system. Thorax side-bend, pelvic obliquity, hip rotation, and knee angulation were exported and processed via Theia3D and Visual3D software for analysis. Correlation analyses were performed to examine the relationship between performance on the SLSD test and lower extremity biomechanics, as measured by joints angles and movement patterns. **Results:** Among 20 student athletes included in this study, 15 (75%) were male and 5 (25%) were female. Most of the participants were right leg dominant (18, 90%). Statistical analysis revealed that hip rotation ($p=0.001$) and knee angulation ($p<0.001$) significantly affected athletes' performance on the timed SLSD test, and more so on the right side compared to the left side. Lesser right knee abduction (Pearson coefficient =0.70, Spearman coefficient=0.69) and right hip internal rotation (Pearson coefficient =0.55, Spearman coefficient=0.61) correlated with better SLSD performance. There was no significant relationship regarding thorax side bend and pelvic obliquity. **Conclusion:** Young athletes with more controlled knee abduction and hip internal rotation may have better SLSD performance compared to those with poorer knee and hip joint control. Further longitudinal studies should examine whether improvements in knee and hip movement control through targeted interventions translate to enhanced SLSD performance and reduced injury. **Translation to Practice** These findings suggest clinicians administering the SLSD test should pay close attention not only to repetition count but also to movement quality, particularly knee abduction and hip rotation control. Incorporating neuromuscular training programs that target frontal- and transverse plane control may help improve SLSD performance and potentially reduce lower-extremity injury risk.

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