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Applications of a Pose-Detection Algorithm for Measuring Hip Impact Velocity During a Fall

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Falls are the leading cause of injury among athlete and elderly populations. The direct cause of fall- induced injury is a mechanical load that exceeds the injury threshold and is applied to the body upon impact. The biomechanical features of a fall have been studied in motion capture environments; however, this method is restricted to experimental settings and has limited applicability to real-life scenarios. The recent emergence of a machine learning based pose-detection algorithm offers a promising solution, as it can be applied directly to video recordings to estimate the orientation and position of human joints. **PURPOSE:** To validate the capabilities of OpenPose, a human pose-detection algorithm, when measuring hip impact velocity of falls. **METHODS:** We used a secondary dataset containing 147 videos of 13 older adults (n = 10 male, n = 3 female, mean age = 64.0 ± 5.9 years) falling in an experimental setting. These videos were accompanied by synchronous motion capture data (VICON), which served as the gold standard reference for the estimation. OpenPose was applied to each video to generate body key points, including the ankle, knee, and hip joints. A MATLAB code was applied to OpenPose and VICON data to calculate fall velocity, defined as instantaneous hip velocity when the hip impacted the ground. To measure agreement between VICON (truth value) and OpenPose (estimated value), the absolute difference of fall velocity (ABS_Diff) was calculated as (OpenPose – VICON), and relative difference (REL_Diff) was calculated as [(ABS_Diff/VICON) ×100%]. These data were grouped based on relative difference (i.e., less than 10% REL_Diff, less than 15% REL_Diff, and all data). Pearson's correlation analyses were performed for each group to determine associations between the fall velocities measured by VICON and OpenPose. **RESULTS:** Overall, the hip impact velocity measured by OpenPose had strong agreement with VICON (ABS_Diff: 0.17 ± 0.13 m/s; Rel_Diff: 7.7 ± 5.3 %). Among 147 videos, 106 videos (72% of data) had less than 10% REL_Diff, revealing a strong and positive correlation between VICON and OpenPose (Pearson's $r = .929$, $p < .01$). 139 videos (95% of data) demonstrated less than 15% REL_Diff, showing a strong and positive correlation between the measures (Pearson's $r = .88$, $p < .01$). When including all data, Pearson's r was .831 ($p < .01$). **CONCLUSION:** OpenPose can accurately measure hip impact velocity during a fall. The pose-estimation algorithm could offer a more feasible approach to quantifying biomechanical features of falls. **SIGNIFICANCE/NOVELTY:** To our knowledge, this is the first study that applies a pose-estimation algorithm to estimate fall biomechanics. Validating this technology in falls could offer a more feasible approach to understanding the mechanisms behind injurious falls and developing interventions to reduce fall-related injuries in both athletes and among the elderly.