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Impact Forces of Unilateral and Bilateral Landings in Various Ballet Jumps

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Biomechanical studies have been conducted regarding ballet jumps and leaps measuring the stresses on the lower extremity with major focus on how the type of shoe and foot position affects landing forces. Although one study compared several different ballet jumps and their different ground reaction force (GRF), little research has been done in comparing jumps that land and takeoff on one foot versus two feet, or looking at the specific joint moments during various movements. **PURPOSE:** This study examined different forces and moments on the lower extremity musculoskeletal system during varied ballet jumps. Specific focus was directed to looking at jumps that both takeoff and land on one or two feet. **METHODS:** 7 ballet dancers (both pre-professional and professional) performed two ballet jumps over force plates, one taking off and landing on one foot (Ballotté), the other taking off and landing on two feet (Changement). 30 reflective markers were placed on the dancers' bodies in order to capture their movements during dance. A 16 camera Vicon Nexus system collected motion and force data of the subjects. **RESULTS:** Landing during the one legged jump and land was more stiff and resulted in greater loads than the two legged jump and land. The peak flexion angle of the knee was greater in the two legged landing (59.5°) compared to the one legged (48.6°, $p < 0.001$). The peak moments of the knee were larger in the one legged landing compared to the two. The extension moment was nearly 15% greater while the abduction moment was 27% greater (1.86 Nm/kg vs. 1.59 Nm/kg and 1.11 Nm/kg vs. 0.81 Nm/kg, respectively). The peak ground reaction force was 30% greater in the one legged landing (1297 N) compared to the two legged (895 N, $p < 0.001$). **CONCLUSION:** As hypothesized, jumps that landed on one foot displayed greater GRF, as well as peak joint moments. These larger stresses on the lower extremity may lead to greater risk of injury for the dancer who regularly engage in jumps and lands on one foot. Ballet teachers may want to consider decreasing how often these jumps are performed in order to lessen the risk of injury. Further research is needed to see if changes in body position/angles of the lower extremity might lead to decreased loading during these jumps and make it possible for instructors to focus on safely teaching these steps.