Title: Biomechanical Adaptation to Mini-Trampoline Hopping in Children with Down Syndrome Compared to Typically Developing Peers

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Introduction: Trampoline interventions have been shown to improve the balance and jumping motor skills in children with intellectual disabilities (Giagazoglou et al. 2013). However, hopping on a compliant surface, similar to a trampoline, demands a specific biomechanical adaptation of increasing whole-body vertical stiffness and maintaining a more vertical lower body posture (Farley et al. 1998). Considering children with Down syndrome (DS) have demonstrated atypical patterns of global and joint stiffness (Ulrich et al. 2004; Galli et al. 2008), it is critical to evaluate their adaptability to a trampoline before supporting a mini-trampoline intervention for this population. The purpose of this study was to characterize the modulation of whole-body vertical stiffness and lower limb kinematics to hopping on a mini-trampoline between children with and without DS.

Method: Data were collected from twelve children with DS and fifteen typically developing (TD) children, aged 7-11 years old. Only eight children with DS (5F/3M, mean (SD) age of 8.36 (1.34) years) completed the protocol for hopping on a stiff surface and on a mini-trampoline. We then age- and sex-matched eight TD children. The children with DS were shorter in height but had similar body mass. Subjects hopped on two feet with their hands on their hips to a metronome cue. The first two bouts of hopping were performed on the stiff surface at 2.3 Hz for ten continuous seconds. Then, subjects hopped on a mini-trampoline at 1.5 Hz for thirty continuous seconds. After at least five minutes of rest, subjects then repeated the bout of mini-trampoline hopping.

Sixteen reflective markers were attached bilaterally to anatomical landmarks of the lower body and a Vicon motion capture system was used to track their positions. Peak vertical ground reaction force was measured from a floor embedded AMTI force plate during hopping on the stiff surface and estimated from Hooke’s Law on the mini-trampoline surface. We calculated whole-body vertical stiffness as the ratio of peak vertical ground reaction force and peak vertical center of mass displacement. We also calculated flight time and hopping height and tracked the angles of four lower body segments, the foot, lower leg, upper leg, and pelvis. Two-way (2 group x 2 surface) mixed ANOVAs were conducted on dependent variables with a significance level set at alpha=0.05.

Result: Both groups increased whole-body vertical stiffness, flight time, hopping height, and medial-lateral foot displacement between hops, and decreased vertical center of mass displacement from a stiff surface to a mini-trampoline. However, the DS group had a shorter flight time and a lower hopping height than the TD group. Further, the DS group had a more vertical thigh segment than the TD group throughout stance phase. While the DS group had a greater foot segment angle than the TD group at touchdown and take-off on a stiff surface, this angle became similar between the two groups on a mini-trampoline.

Discussion: Our results suggest that children with DS aged 7-11 years have the capacity to increase whole-body vertical stiffness while hopping on a mini-trampoline. Further, mini-trampoline hopping potentially improved the kinematic pattern around the ankle joint demonstrated by a more vertical orientation of the foot segment. Considering children with DS often compensate for ankle joint dysfunction (Galli et al. 2008), mini-trampoline hopping might be a safe and effective intervention tool for this population to improve their motor function.

References/Citations: