Kinematic Differences Between Children with and without Sarcopenic Obesity, During Vertical Jumps

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Summary

Children with Sarcopenic Obesity (SO) may exhibit distinct neuromechanical adaptations due to altered body composition. This study analyzed lower limb kinematics during vertical jumps in children with and without SO. We found SO children showing greater hip and knee extension in the propulsion phase of countermovement jumps and increased knee valgus, knee internal rotation, and ankle dorsiflexion in drop landings. These findings suggest that SO affects movement strategies in children, particularly at the knee, potentially increasing injury risk and limiting participation in high-impact activities.

Introduction

Obesity is a 21st-century epidemic with significant global health impacts, particularly in children, due to its multisystemic effects on growth and development [1]. Sarcopenic Obesity (SO), characterized by a low muscle-to-fat ratio, is increasingly studied for its functional and structural consequences in pediatric populations [2]. Children with similar body mass and height can have different muscle and fat distributions, leading to distinct musculoskeletal impairments [3]. Such characteristics may influence the biomechanics of jump landing, increasing exposure to risk factors for lower limb injuries. Here, we investigate whether jump kinematics differ between SO children and controls.

Methods

Fourteen SO children and 16 controls without SO were recruited (IRB BIOEPUCV-H 669-2023). SO was assessed using iDXA (GE Healthcare Lunar, Madison, USA), with the appendicular muscle mass and total body fat mass used to calculate the Muscle-to-Fat Ratio (MFR) for classification purposes [4].

Kinematic data were collected using a 7-camera motion analysis system (Vero v1.3, Vicon Nexus 2.16, Oxford, UK) sampling at 100 Hz. Sixteen 14mm reflective markers were placed according to the Plug-In-Gait model. After a 2-minute warm-up, each participant performed three countermovement jumps (CMJ) and three drop landings (DL) in a randomized order. Kinematic data were smoothed using a 4th-order Butterworth low-pass filter (cutoff: 10 Hz) and trimmed from movement onset (0%) for CMJs, and from initial ground contact (0%) for DLs, to the start of a plateau in the vertical position of pelvis markers (100%) for both jump types.

Hip (X, Y, Z), knee (X, Y, Z), and ankle (X, Y) joint angular position time series were interpolated using a custom MATLAB (R2018a) script to create a 101-point vector for the complete duration of each jump movement. A Statistical Parametric Mapping (SPM) two-tailed two-sample t-test was applied to compare joint angular positions between SO children and controls (α=0.05).

Results and Discussion

No differences between groups were found in age, height or body mass. SO children had a lower MFR (0.71 ± 0.18 vs 1.45 ±0.62 u.a., $p<0.01$) and lower CMJ height (27.01 ± 4.91 vs 33.07 ± 7.76 cm, $p<0.01$).

In CMJ, SO children exhibited greater hip extension during 11–26% ($p<0.01$), 47–67% ($p<0.01$), and 78–85% ($p<0.01$) of the movement cycle, as well as greater knee extension during 47–51% ($p<0.05$) and 58–66% ($p<0.01$). In DL, SO children showed increased knee flexion during 11–18% ($p<0.05$) (figure 1 as an example of comparative curves), greater knee valgus during 7–12% ($p<0.05$), increased knee internal rotation during 5–12% ($p<0.05$), and greater ankle dorsiflexion during 3–14% ($p<0.05$) compared to controls.

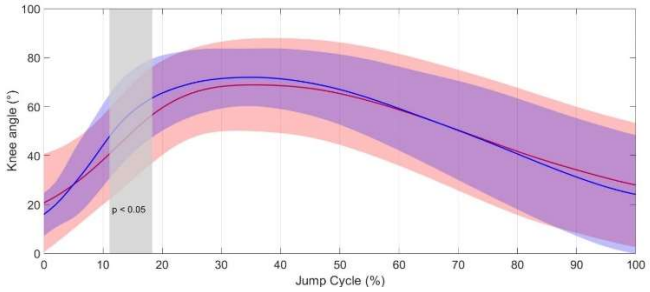

Figure 1. SPM t-test for the knee in the sagittal plane

SO children in this study may have adopted different neuromechanical strategies during vertical jumps, particularly involving knee kinematics, which influence may result from the higher MFR in these children. Such changes could increase the risk of injury and pose challenges for participation in more physically demanding activities, such as sports or recreational tasks.

Conclusions

During vertical jumps, children with SO exhibit altered lower limb kinematics, suggesting poorer movement control, especially for the knee joint.

References

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