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Influence of body weight on joint loading in stair climbing

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Introduction

Keywords: joint loading, stair climbing, obesity

Exercise is an essential treatment in childhood obesity. Due to the low impact on joint loading exercise recommendations are aerobic exercise such as swimming, cycling and walking (Hassink et al., 2008). Little is known though about the effect of adiposity on the function of the locomotor system (Wearing et al., 2006). Only limited research has been done on obese gait in children (Nantel et al. 2006) and even less is known about other weight bearing tasks such as climbing stairs. Therefore, the aim of this study was to examine the influences of obesity on the load pattern of the lower extremity joints of obese children while ascending and descending stairs.

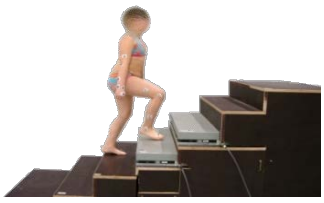
Methods

Subjects:
17 normal weight children
Ø age: 10.4 ± 1.3 yrs, Ø height: 143 ± 9 cm,
Ø BMI: 25.4 kg/m² = P: 99.5
18 obese children
Ø age: 10.5 ± 1.5 yrs, Ø height: 148 ± 10 cm,
Ø BMI: 18.2 kg/m² = P: 9 .75

Condition:
Barefoot
Pace: 110 steps/min
3 valid trials

Data collection:
1 staircase with 6 steps (17 cm x 28 cm)
2 embedded force plates (AMTI, 1000 Hz)
10 MX cameras (Vicon, 200 Hz)

Data analysis:
Model: Vicon Plug-in Gait
Dynamic data: normalized to body weight,
time normalized: 1 gait cycle
Parameters: mean peak values of ankle,
knee and hip joint moments
sagittal and frontal plane
Statistics: independent t-tests, $p \leq 0.05$



Results

The normalized to weight data show quite similar load patterns between obese and normal weight children. Only the load pattern of the hip moment in sagittal plane shifts from a flexion moment (normal weight) to an extension moment (obese) when climbing downstairs (Fig. 3). Hence a difference in the maximum moment in the sagittal plane appears (obese: 0.12±0.19Nm/BW, normal: 0.33±0.25 Nm/BW). Additionally the obese group reveals a higher maximum adduction moment of the hip in the frontal plane when walking upstairs (obese: 0.72±0.14 Nm/BW, normal: 0.64±0.13 Nm/BW). At the knee significant higher extension moments up and downwards can be observed for the obese children. (obese: up: 1.10±0.28 Nm/BW; down: 1.01±0.24 Nm/BW normal: up: 0.91±0.19 Nm/BW; down: 0.91±0.34 Nm/BW) (Fig 4). No differences can be found in the maximum ankle moments.

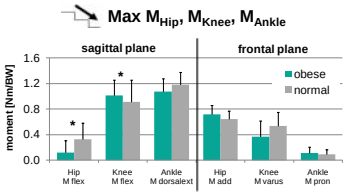


Fig. 1 Maximum moments of the hip, knee and ankle and joint, downstairs, right leg

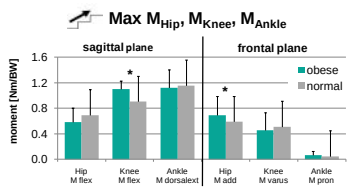


Fig. 2 Peak moments of the hip, knee and ankle and joint, upstairs, right leg

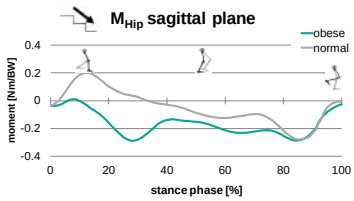


Fig. 3 Hip moment in sagittal plane, downstairs, right leg

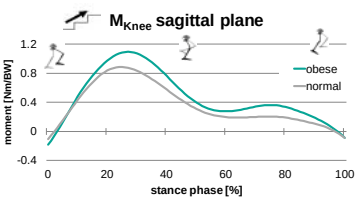


Fig. 4 Knee moment in sagittal plane, upstairs, right leg

Discussion and Conclusion

This data provides an additional piece to the understanding of the effect of excessive overweight on the locomotor system. The data, normalized to weight, indicates only small differences in the load pattern of the lower extremities between children of normal and excessive weight in stair climbing. Even though these differences are only about 10% of body weight at the knee moment, they should not be neglected considering the absolute joint moments overweight children have to deal with.

References

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