Effects of flatfoot and excessive body weight on lower limb biomechanics and muscle activation in females using statistical parametric mapping

Linjuan WEI[1], Guoxin ZHANG[1], Yan WANG[1, 2, 3], Jason Tak-Man CHEUNG[3], Hejin CAI[1], Fangbo BING[1], Ming ZHANG[1,2,3 *]
[1]Department of Biomedical Engineering, Faculty of Engineering, The Hong Kong Polytechnic University, Hong Kong, China
[2]The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen, China
[3]Research Institute for Sports Science and Technology, The Hong Kong Polytechnic University, Hong Kong, China
Email: ming.zhang@polyu.edu.hk

Summary

Excessive body weight and flexible flatfoot (FFF) can increase the risk of musculoskeletal issues. This study explored how these factors affect female's lower limb gait patterns during the stance phase by examining kinetics, kinematics, and muscle activations using statistical parametric mapping. For females with FFF, excessive body weight increases vertical ground reaction force and hip extension angle while decreasing vastus medialis and biceps femoris muscle activity during the late stance phase. For overweight and obese females, FFF leads to higher ankle joint contact force at initial contact, increased hip extension angle, and reduced biceps femoris activity. Excessive body weight has effects similar to FFF in females. Weight reduction is advised for overweight and obese females. For overweight and obese females with FFF, exercises to enhance joint stability are recommended to prevent joint injuries. The findings from this study could improve healthcare for overweight or obese females with FFF.

Introduction

Overweight and obesity can induce morphological changes in the lower limbs, such as flexible flatfoot (FFF) which can affect the biomechanical of the lower limbs. Those biomechanical related changes are associated with a higher risk of lower limb musculoskeletal disorders. Comprehensive information of biomechanics is helpful for early management and targeted interventions to minimize related various musculoskeletal issues.

Methods

This study involved 24 females in three groups: eight overweight-obese females with FFF, eight overweight or obese with normal foot, and eight normal weights with FFF. Walking data were collected include marker trajectories (Vicon Motion System Ltd., Oxford, UK), GRF (OR6, AMTI, Watertown, US), and surface electromyography (Delsys Inc., Boston, MA). Joint angles, joint moments, and joint contact forces were calculated using a musculoskeletal modeling simulation software (AnyBody 7.3, Anybody Technology, Aalborg, Denmark). The outcomes were analyzed using statistical parametric mapping.

Results and Discussion

For females with FFF, overweight and obese increased vertical GRF and hip extension angle while reduced muscle activation of vastus medialis and biceps femoris during the late propulsion period (Figure 1). For females with overweight and obese, FFF increased ankle joint contact forces at the initial contact, and increased hip extension angle and decreased biceps femoris muscle activation during the propulsion phase. Overweight and FFF have similar effects on lower limbs in females. Excessive body weight and FFF can cause joint instability in the knee and hip or increase ankle joint loading in females. Weight reduction is recommended for females with excessive body weight, and exercises that enhance joint stability are advised for those with both excessive body weight and FFF.

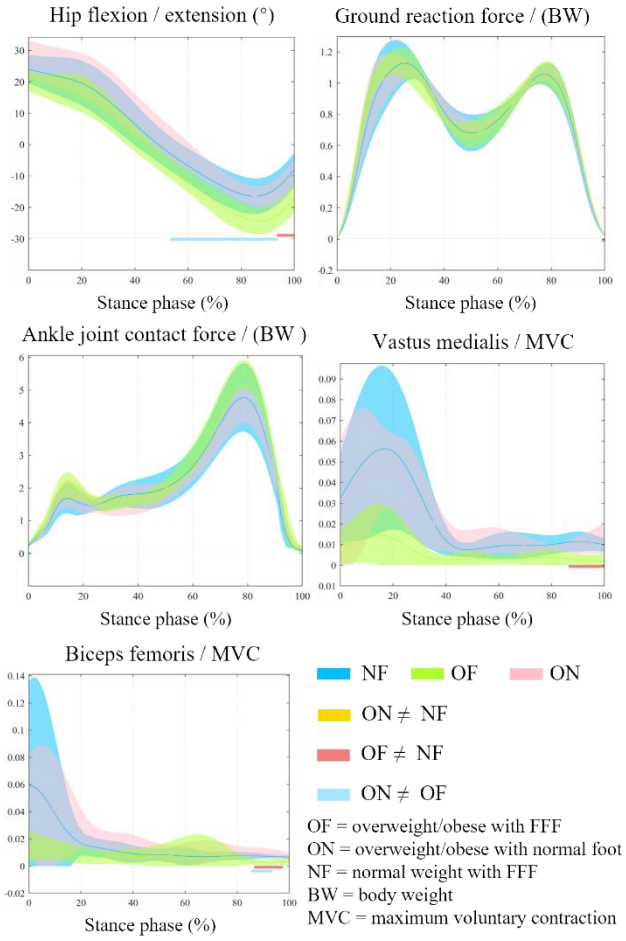

Figure 1: Parameters that showed significant difference.

Conclusions

For overweight and obese females with FFF, exercises to enhance joint stability are recommended to prevent joint injuries.

Acknowledgments

This work was supported by the Research Grants Council (PolyU 15211322).