Biomechanics of stationary exercise: An option for weight management

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Abstract

Children carrying excess mass have difficulty performing exercises requiring whole body movement with horizontal displacement, such as walking and running. While previous research strongly suggests that overweight children adapt their gait to accommodate for moving excess mass horizontally, very little research has investigated the biomechanical characteristics of simple exercises that focus on vertical displacement, such as stationary exercise. In addition, aquatic exercise has not been considered as an alternative solution for this population. Therefore, the purpose of this thesis was to compare the biomechanical differences between aquatic- and land-based stationary exercises in normal-weight and overweight children.

Methods

This thesis involved four parts; literature review, technical note, biomechanics of land- and aquatic-based stationary exercise. The literature review includes a summary about the prevalence of paediatric obesity and its related physical dysfunction, as well as the drafted literature review manuscript on biomechanical differences in exercises overground and within shallow water. It is followed by a technical note study to examine the accuracy of the camera setup by comparing the angular kinematics collected using a recreational, low-cost sports video camera (GoPro, Inc) and commercial inertial motion sensors, in both land and water environments. Following the validation study, there are two cross-sectional studies that investigate the differences in lower extremity kinematics, spatiotemporal parameters, rate of perceived exertion (RPE) and muscle activation patterns, in normal-weight and overweight children during water- and land-based stationary exercises.

Results

The literature review revealed that the previous aquatic biomechanical research is limited to aquatic gait in adults and elderly people. The lack of aquatic research in children is of great concern, as aquatic sports provide a low weight bearing activity that diminishes the likelihood of injuries in children and provides a solid foundation for physically activity throughout the lifespan.

We demonstrated that the GoPro camera derived angular velocity measurements underwater and in air are accurate when compared to data from inertial sensors and known motion of the clock's second hand and a driven limb segment model. Thus, the accuracy of thesis protocol was established.

The findings of the two cross-sectional studies demonstrated that children with excess body mass experienced significantly greater RPE and muscle activation with more extended joints during land-based stationary exercises. However, these differences diminished between groups in water with a lower RPE in overweight children and a more upright posture for both groups.

Conclusions

These findings suggested that children with excess body mass may adopt a more active neuromuscular strategy and a more upright posture in order to provide greater stability and propulsion during land-based stationary exercises. Higher RPE scores could indicate a greater level of difficulty and lack of enjoyment when performing stationary exercise on land. However, these differences did not exist in water. Thus, these findings support stationary exercises in water as a desirable way to reduce functional differences and subsequently promote physical activity in overweight children.

Preface

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