# HOW DOES OBESITY AND GENDER AFFECT FOOT SHAPE AND STRUCTURE IN CHILDREN?

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## INTRODUCTION

Obesity is a prevalent disease of today's society which has many negative consequences which affect an individual's quality of life. One system of the human body which is affected by obesity is the musculoskeletal system as it must endure the added mass and adiposity on a daily basis. It has been suggested that pathologies of the lower extremity may be exacerbated in obese individuals as a consequence of increased mechanical loading of the lower limbs by their additional mass (1-3).

As the feet are the foundation for stance and dynamic tasks, it is postulated that the increased loading associated with obesity would place the feet at risk of pathology. Obese children have been found to display an increased plantar contact area compared to non-obese children (3-5). In addition the foot shape and dimensions of obese children's feet were found to be different from children of normal mass. However, this was found in a small sample of 10 obese children therefore it is unclear whether this relationship exists in a larger sample of obese children. These children displayed significantly larger foot shape dimensions for 17 out of the 26 measurements recorded. These children's feet were broader, taller and thicker in comparison to the non-obese children (7). Therefore the purpose of this study was to determine whether the foot shape and foot structure characteristics of obese children's feet could be replicated in a larger population of children and whether it was moderated by gender.

## METHODS

Forty-five obese (30 girls and 15 boys; 9.2 ± 1.4 years; BMI 24.98 ± 2.6 kg/m$^2$) children in the 7 to 12 year age group were matched to 45 non-obese children (9.2 ± 1.4 years; BMI 16.34 ± 1.2 kg/m$^2$), for gender, age and height. Height and weight were measured to calculate body-mass index and classified according to international cut-off values. Right and left static footprints were obtained using a pedograph to calculate the Arch Index of each child's feet to characterise foot structure. Twenty-six foot shape variables (lengths, breadths and circumferences) for both the right and left feet were recorded to characterise foot shape (8). Paired *t*-tests revealed 10 significant differences between the right and left limbs of the 90 subjects. Therefore, a random foot was selected for each subject via a random number generation for each subject before further analyses in order to limit any bias in the data.

Means and standard deviations were calculated for the total sample for Arch Index derived from the footprints and the foot shape values. After testing for normality and equal variance, two-way analyses of variances (ANOVA; $p<0.05$) were calculated using the random foot data to determine whether there were any main effects of age and/ or gender on the dependent variables.

## RESULTS AND DISCUSSION

The mean Arch Index values obtained for the obese and non-obese children were 0.23 ± 0.05 and 0.17 ± 0.08, respectively. While standing the obese children generated significantly greater plantar contact area indicating flatter feet compared to their non-obese counterparts, plantar contact area however was not affected by gender. Similarly, obese children have significantly greater foot dimensions for 17 of the 26 variables ($p\leq0.05$). The non-obese children displayed greater mean values for only two ankle dimensions although this was not significant. However, gender did affect the shape of the foot in children regardless of body type. In general the foot shape parameters were greater for the boys compared to the girls.

From these results, it is evident that obese children have significantly broader, higher, and thicker structural features in their feet compared to their non-obese counterparts. The results in this study encompass a larger population of children and similar trends are showing through this data set more clearly than Dowling & Steele's (2001) and have greater mean foot shape values in comparison which may reflect the increasing prevalence of obesity in children. However, no significant interactions between gender and obesity were found for the dependent variables.

## CONCLUSIONS

Gender did affect the foot shape and structure in children regardless of their body type. The mechanism behind the obese child's foot shape and structure is currently unknown therefore more research is warranted examining the bone density and bone stresses to determine definitely whether obesity is detrimentally affecting the musculoskeletal architecture of obese children.

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