Foot morphology in normal-weight, overweight, and obese schoolchildren

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Abstract This study compared the foot morphology of Spanish schoolchildren based on their body mass index and age and analyzed whether body mass index affects the child’s foot development at primary school. Cross-sectional study of 1,032 schoolchildren (497 boys and 535 girls), 6–12 years old. Height and weight were measured to calculate body mass index. Children were classified as obese, overweight, and normal-weight. Measurements of foot morphology were obtained with a three-dimensional feet digitizer in static standing. Significant differences were found between the feet of children with normal-weight and overweight (2.6 to 9.0 %) and among children with normal-weight and obese for all variables (3.9 to 17.3 %). Differences in width, ball height, and arch height (5.3 to 7.6 %) were only found among overweight and obese children. There were no changes in the foot morphology of children between 6 and 7 years and between 10 and 12 years. Obese children showed more gradual changes in the foot measurements. The average percentage increase by year in children with normal-weight and obese were similar (3.6 and 3.4 %, respectively); however, morphological measurements of the foot of overweight children increased at a faster rate (4.0 %). Conclusion: Excess weight affects the foot structure of children. The differences between age groups seem to indicate that the feet of children with overweight and obesity follow a different growth pattern than that of normal-weight children. With these results, the shoe manufacturers can design shoes for children depending on their age and weight.

Keywords Body mass index (BMI) · Foot structure · Primary school · Arch index · Footwear

Abbreviations
BMI Body mass index
FA Footprint angle
CSI Chippaux–Smirak index
AI Arch index

Introduction

Currently, the prevalence of overweight is reaching “epidemic” levels in many developed countries [29, 40]. There has been a worldwide increase in obesity in people of all ages [37]. In Spain, several studies have shown that approximately 30 % of children aged 6 to 13 are overweight and obese [2, 13, 19, 25].

Childhood obesity is associated with long-term consequences for health [26, 29] and for the musculoskeletal system, including misalignment of the lower limbs [45]. The orthopedic problems relating to overweight and obesity include musculoskeletal pain and discomfort [16, 39], problems in the feet, ankles, knees, hips, and spine [14, 28], risk of fractures, growth, and development disorders [27, 41]. There is also a reduction in flexibility and as well as difficulty in walking and running [37] due to changes in the foot structure. However, the most frequent condition appears to be flat feet [8, 9, 28, 32, 33]. Because of that, excess weight causes changes in the plantar arch, by changes in osseous and ligamentous support [24] and a collapse of the medial longitudinal arch that may become a problem in adulthood [36].

The child’s foot is constantly growing, changing its shape and structure. The morphology and functional development of the foot are influenced by internal factors (sex, genetics, and age) and external factors (footwear habits, loading, and physical activity) [10, 21]. Because the foot structure of children is not fully developed, the influence of ill-fitting shoes...