

SHOULD CHILDREN'S SHOES BE SCALED DOWN VERSIONS OF MEN'S SHOES?

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INTRODUCTION

Footwear, if designed appropriately has the ability to aid the body in dissipating the high forces generated at each footfall during physical activity (Cheskin et al., 1987). However, irrespective of how sophisticated the design features are within a shoe, if the shoe does not fit the wearer, it will not perform as required. In order for a shoe to fit, shoe shape should match foot shape. Evidence has suggested that ill-fitting shoes may cause discomfort and, in turn, foot pathologies and deformities (Cheng & Perng, 1999). Therefore, it is imperative that shoes are manufactured to fit the feet of target wearers.

Although there is substantial research pertaining to the structure and shape of adult male feet (Cheskin et al., 1987), there is a dearth of research information available regarding the size and shape of children's feet. In fact, most athletic shoes commercially available for children are merely scaled down versions of adult shoes. However, within the limited literature pertaining to children's feet, Bleck (1971) noted that the shape and configuration of a child's foot did not conform to the shape of standard shoe lasts. Furthermore, gender differences in foot shape have been confirmed in adults (Wunderlich & Cavanagh, 2001), although whether these same gender differences exists in children is not known. Therefore, the purpose of this study was to determine whether children's foot shape and proportions differed to data reported for adult foot shape, and whether children's foot shape was moderated by gender.

METHODS

Four hundred and thirty-seven consenting 7-12 year old children (234 girls, 203 boys) without musculoskeletal pathologies were recruited from 27 randomly selected consenting primary schools located throughout New South Wales, Australia. To characterise the external shape of the feet and distal leg of the children, 26 anthropometric dimensions were measured for the right and the left lower limbs of each subject following the protocols outlined by Parham et al. (1992). The absolute foot anthropometric data were then normalised for both foot length and standing height to enable later comparisons of foot shape between children of different gender and between children and adults.

Paired *t*-tests were initially conducted to identify whether there were any significant differences between the left and right feet of the 437 children with respect to the foot anthropometry data. Significant between-limb differences ($p < 0.05$) were noted for the 437 subjects, although on average these differences were less than 3.5 mm. Due to this asymmetry, one foot per subject was selected, using a random number generation, before further analyses in order to limit any bias in the data. Independent *t*-tests were then calculated to determine whether there were any significant differences between the boys and the girls when the anthropometric measures were normalised to foot length and or standing height. The children's foot shape was then compared with right foot data collected for adults by Parham et al. (1992) and presented by Wunderlich and Cavanagh (2001).

RESULTS AND DISCUSSION

The results of this study indicate that, for a given stature, boys have significantly ($p \leq 0.001$) longer and wider feet compared to girls (Table 1). On average, boys had longer feet by 0.18% of height and broader

feet by 0.15% of height compared to girls. When the foot dimensions were normalized for foot length, 11 of the 25 indices (ankle, medial and lateral malleolus, dorsal arch heights, heel-ankle, instep, ball of foot circumferences, bimalleolar, 1st-3rd toe, diagonal and horizontal ball of foot breadths) were significantly greater for the boys relative to the girls. In contrast, calf circumference was significantly greater ($p = 0.010$) for the girls compared to the boys. These results suggest that gender significantly moderated both foot shape and foot dimensions.

Compared to adult data, foot length as a percentage of standing height was greater for both boys and girls, however, contrary findings were found for foot breadth as a percentage of standing height whereby male and female adult values were higher than values for the children. When comparing the foot dimensions calculated for the children in the present study against similar data calculated for adults (see Table 1), it is evident that the shape and proportion of children's feet are different compared to adults.

Table 1 Foot length and diagonal foot breadth values normalized by standing height for the boys (n = 203) and girls (n = 234) and values for men (n = 293) and women (n = 491) from Wunderlich and Cavanagh (2001). Estimates of these values are calculated for boys, girls, men and women at 1.5 m tall.

Variable	Dowling & Steele		Wunderlich & Cavanagh	
	Boys	Girls	Men	Women
Foot length (% height)	15.69%	15.51%	15.36%	15.01%
Foot breadth (% height)	5.86%	5.71%	6.00%	5.87%
Foot length for height of 1.5 m	23.53 cm	23.26 cm	23.04 cm	22.51 cm
Foot breadth for height of 1.5 m	8.79 cm	8.56 cm	9.00 cm	8.80 cm

CONCLUSIONS

It was concluded that children have differing foot shape dimensions and proportions compared to adults, although children's feet, like adult feet, are affected by gender. Therefore, it is recommended that children's shoes should not be manufactured as scaled down versions of men's shoes as this will not foster appropriate shoe fit. Instead, it is recommended that children's shoes be based on lasts developed to cater for the specific needs of juvenile feet.

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