

THE INFLUENCE OF FOOTWEAR ON THE PREVALENCE OF FLAT FOOT

A SURVEY OF 2300 CHILDREN

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We analysed static footprints of 2300 children between the ages of four and 13 years to establish the influence of footwear on the prevalence of flat foot.

The incidence among children who used footwear was 8.6% compared with 2.8% in those who did not ($p < 0.001$). Significant differences between the predominance in shod and unshod children were noted in all age groups, most marked in those with generalised ligament laxity. Flat foot was most common in children who wore closed-toe shoes, less common in those who wore sandals or slippers, and least in the unshod.

Our findings suggest that shoe-wearing in early childhood is detrimental to the development of a normal longitudinal arch.

In Europe and America flat foot is a common reason for attendance at a children's orthopaedic clinic (Sharrard 1979), but in India children are seldom brought for treatment for flat foot. The few children who do attend with this complaint are from affluent urban families and they all wear shoes. In our clinic we have never seen a child from the farming community or from the family of a manual labourer who complained of flat foot.

If the incidence of flat foot is so low among the rural population, is it because these children do not wear shoes? The use of footwear is known to increase the risk of hallux valgus (Sim-Fook and Hodgson 1958; Shine 1965) and to decrease the incidence of hallux varus (Joseph, Jacob and Chacko 1984; Joseph et al 1987). Does the wearing of shoes also influence the development of the medial longitudinal arch?

Our aims were to establish the prevalence of flat foot in a population of schoolchildren in rural India and to determine whether this prevalence varied between shod and unshod children.

MATERIAL AND METHODS

Our survey included 2300 children (1237 boys and 1063 girls) between the ages of four and 13 years from four

Kannada-speaking (vernacular) and two English-speaking schools. All six schools were located in an area with a radius of 10 km and all the children were from a common ethnic background. School attendance in the region is generally good and all the children at school on the day of the screening were included in the study (Table I). Static footprints of both feet were obtained from all 2300 children using the differential pressure footprint mat of Harris and Beath (1947) as described by Rose, Welton and Marshall (1985).

The footprints were classified as normal, high-arched or flat (Fig. 1). Some form of footwear was worn by 1555 children while 745 never used shoes. All the children in the English-speaking schools used footwear; 50.7% of children in Kannada-speaking schools did not use footwear.

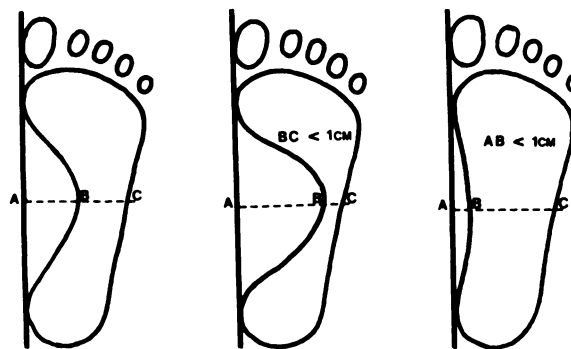


Fig. 1

Method of grading footprints. If the width of the instep (AB) at its widest part was less than 1 cm the foot was considered as flat (right). If the width of the footprint at its narrowest part (BC) was less than 1 cm, the arch was considered high (centre). All other footprints were considered normal (left).

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Table I. The number of children in each of the six schools and their shoe-wearing habits

Language/ location of school	Total strength	Children screened		Footwear of children screened (percentage)			
		Number	Per cent	Closed-toe shoes	Sandals	Slippers	None
Kannada/Parkala	543	501	92.3	1.6	14.2	21.3	62.9
Kannada/Kadiyali	542	536	98.9	3.5	35.4	19.1	42.0
Kannada/Manipal	252	216	85.7	4.2	21.7	21.3	52.8
Kannada/Saralabettu	210	197	93.8	2.0	22.4	34.5	41.1
English/Indrali	263	254	96.6	32.8	34.0	33.2	0
English/Manipal	630	596	94.6	37.7	13.0	49.3	0

Table II. The prevalence of flat foot and high-arched foot at different ages

Age (yr)	Flat foot (per cent)	High-arched feet (per cent)
6	14.9	14.3
7	9.1	17.6
8	7.9	26.5
9	5.3	25.5
10	3.8	28.3
11	3.3	31.4
12	2.2	36.9
13	2.5	40.5

The weight of each child was measured on a scale with an accuracy of 100 g; their height was measured by a stadiometer. The Body Mass Index (BMI) was calculated for each child by dividing the weight (kg) by the square of the height (m). Individuals with a BMI of over 24 were considered to be overweight (Bray, Jordan and Sims 1976).

We examined each child for features of ligamentous laxity of the thumbs, fingers, elbows, knees and ankles. Hypermobility of two or more joints bilaterally was taken to indicate generalised ligament laxity. Genu valgum, femoral and tibial torsional abnormalities and shortness of the calcaneal tendon were noted. We performed Jack's test on all feet which were flat (Jack 1953).

RESULTS

Of the 2300 children studied, 1551 were considered to have normal arches in both feet, 595 had a high arch in one or both feet and 154 (6.7%) had unilateral or bilateral flat foot. The prevalence of flat foot progressively decreased with increasing age (Table II); it was 12.1% among children attending English-speaking schools and 3.5% in those at Kannada-speaking schools ($p < 0.001$). There was a significantly higher prevalence in children who wore shoes (8.6%) than among the unshod (2.8%)

Table III. The distribution of footprint types among children wearing different forms of footwear and unshod children. The percentage of flat foot in each group is shown in parentheses

Footprint	Closed-toe shoes	Sandals	Slippers	Unshod	Total
Normal	243	335	508	462	1548
High-arched	53	147	130	262	592
Flat foot	45 (13.2)	31 (6.0)	57 (8.2)	21 (2.8)	154
Total	341	513	695	745	2294*

*six children were not included as they wore different types of footwear during the year

($p < 0.001$). The frequency of flat foot in children wearing various types of footwear is shown in Table III.

Of those with flat foot, only four were rigid and had a negative Jack's test. Ligament laxity was detected in 710 children. The ratio of flat foot in children with ligament laxity was 14.4% compared with 3.3% in those who had no ligament laxity.

The mean BMI for children with flat foot was 14.72 (± 2.05 SD) and for those without flat foot it was 14.61 (± 2.0 SD). This difference is not statistically significant.

DISCUSSION

The overall prevalence of flat foot in this study was comparable with that reported by Morley (1957). At ten years of age, however, among unshod children it was very low, while in the shod children it was as high as Morley's value.

The distinctly higher incidence in children who used footwear suggests that shoe-wearing predisposes to flat foot. Before accepting a causal relationship, however, some confounding variables should be excluded. Among factors known to be associated with flat foot are ligament laxity and obesity (Sharrard 1979). It has also been established that there is a tendency for the arch to improve spontaneously with age (Morley 1957) as was also shown in our study (Table II). A higher proportion of younger children or children with ligamentous laxity among those who wore shoes, however, did not account for the high incidence of flat foot in them since the trend

Table IV. Percentage of normal, high-arched and flat feet among shod and unshod children in various age groups

Age (yr)	Number shod	Number unshod	Normal feet		Unilateral/bilateral high arch		Unilateral/bilateral flat foot		p-value
			Shod	Unshod	Shod	Unshod	Shod	Unshod	
<6	231	97	70.1	72.1	12.6	18.6	17.3	9.2	NS
7 to 8	465	177	72.9	61.0	17.0	34.5	10.1	4.5	0.001
9 to 10	506	242	70.2	65.2	23.3	34.3	6.5	0.4	0.001
>11	353	229	66.0	55.0	30.3	43.7	3.7	1.3	0.001

Table V. Percentage of normal, high-arched and flat feet among shod and unshod children with and without generalised ligament laxity

	Age (yr)	Number shod	Number unshod	Normal feet		Unilateral/bilateral high arch		Unilateral/bilateral flat foot		p-value
				Shod	Unshod	Shod	Unshod	Shod	Unshod	
Lax ligaments	<6	127	50	65.4	76.0	14.2	12.0	20.5	12.0	NS
	7 to 8	182	65	67.0	56.9	13.2	33.8	19.8	9.2	0.001
	9 to 10	132	52	64.4	78.8	21.2	14.4	0	0.05	
	>11	65	37	58.5	54.1	29.2	43.2	12.3	2.7	NS
Normal ligaments	<6	104	47	76.0	68.1	10.6	25.5	13.5	6.4	0.05
	7 to 8	283	112	76.7	63.4	19.4	34.8	3.9	1.8	0.01
	9 to 10	374	190	72.2	61.6	24.1	37.9	3.7	0.5	0.001
	>11	288	192	67.7	55.2	30.6	43.8	1.7	1.0	0.05

was seen in all age groups (Table IV) and was independent of the presence or absence of ligament laxity (Table V). In addition, there were no obese children in the study.

In each of the groups analysed, we noted an inverse relationship between the prevalence of flat foot and of high-arched feet. This suggests that any factor detrimental to the development of a normal arch leads to a low proportion of high-arched feet and a high one of flat foot, as was seen in children who used footwear.

The preponderance of flat foot also varied with the type of footwear. It seems that closed-toe shoes inhibit the development of the arch of the foot more than do slippers or sandals. This may be because intrinsic muscle activity is necessary to keep slippers from falling off. Rural Indian children who normally use footwear, tend to play barefoot, and this is more common among children who wear slippers and sandals as they are more easily removed than shoes. Such interludes of unshod activity may account for the lower prevalence of flat foot in these children. These observations are contrary to the statement of Kelsey (1982) that there is no evidence that the type of footwear influences the occurrence of flat foot.

The high concentration of flat foot among six-year-old children who wore shoes as compared with those who did not, implies that the critical age for development of the arch is before six years. This hypothesis is supported by the observations of Rose et al (1985) who noted that 'treatment' for flat foot instituted after the age of four is less effective than that begun earlier.

Our cross-sectional study suggests that shoe-wearing in early childhood is detrimental to the development of a normal or a high medial longitudinal arch. The susceptibility for flat foot among children who wear shoes is

most evident if there is associated ligament laxity. We suggest that children should be encouraged to play unshod and that slippers and sandals are less harmful than closed-toe shoes.

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