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Original Research Article

ASSESSMENT OF STAHELI ARCH INDEX IN TRIBAL CHILDREN OF JHARKHAND STATE

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ABSTRACT

Pes planus and pes cavus are the two common foot conditions, which fascinate the attention of researchers. A deviation from normal foot arch structure is associated with unstable gait. This study aims at assessing the staheli arch index (SAI) of Jharkhand tribal children. This study was carried out on children belonging to various tribal groups of Ranchi and Angara districts of Jharkhand. Graphical footprints of the study subjects were recorded and assessed using SPSS-16. The mean right SAI was 0.63 and 0.61 for right and left foot respectively. The mean right SAI was significantly greater than that of left foot. Gender differences in mean SAI was statistically insignificant at $p<0.05$. The mean SAI of 0.75 and 0.76 at the age of 3:<4 years was reduced to 0.64 and 0.61 by 14:<15 years age for right and left foot respectively. There was insignificant correlation of SAI with age and body mass index ($p < 0.05$).

KEY WORDS: Staheli arch index, Pes planus, Pes cavus.

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INTRODUCTION

Human foot possesses a special intricate mechanism responsible for bipedal gait. Osteo-ligamentous plates in the foot act like springs to propel the body forwards. There are transverse and longitudinal arches. Entire body weight transfers on to the toes through arches. They absorb mechanical shock, dissipate the impact forces and further help in even distribution of weight. Medial longitudinal arch (MLA) of foot is comprised of many bones and ligaments that make it more resilient. The position of talus determines the height of the arch. Laxity of the ligaments, modification in bone structure can lead to pes planus (PP) & pes cavus (PC) foot. PP is a foot condition in which larger plantar area of the foot is exposed to the ground. It indicates low or absence of MLA. PC is a foot condition in which MLA does not flatten on weight bearing. PP is common in

childhood. Bones are in growing stage during childhood. Influence of external factors like ground reaction forces can greatly influence the developing foot arch structure. Foot types that differ from normal are associated with different injury patterns. Subjects experience more pain during high impact activities such as running and jumping due to more amount of stress in the calf and ankle regions [1]. PC foot condition was found to be associated with back pain [2].

MATERIALS AND METHODS

Tribal children of Jharkhand (JH) state were included in this study. Written consent from parents and school authorities of the study subjects was obtained prior to the study. It was a cross sectional study conducted on 360 male and female children of 3:<15 years age. Any children who underwent surgical treatment, suffering from lower limb injury or neurological disorders were excluded from this study.

Height was measured in centimeters using a flexible metallic tape. Weight was measured in kilograms using manual weighing scale [3]. Body mass index (BMI) was calculated basing on height and weight measurements. Footprints of both feet were collected on graph sheets. Each child was asked to thoroughly wash their soles to get rid of any dust particles. Feet were soiled with ink using a customized stamp pad. Outline of the feet using a sharp pointed pencil were traced immediately after procurement of footprints. All the graph sheets were properly labeled with name of the subject & guardian and age to avoid any confusion. Smeared footprints were excluded for further evaluation [4].

For attaining Staheli arch index (SAI) a line is drawn tangent to the medial forefoot edge and at heel region, the mean point of this line is calculated. From this point, a perpendicular line is drawn crossing the footprint. The same procedure is repeated for heel tangency point. We thereby, obtain the measurement of the support width of the central region to the foot (A) and of the heel region (B) in millimeters (Figure-1). The SAI is obtained by dividing minimum sole width A value to maximum heel width B value (AI = A/B) [5].

SAI between 0.5-0.7 was considered as normal foot (NF). SAI > 0.7 was considered as flat foot/ PP and <0.5 as high arch foot/PC [6,7].

Fig. 1: Footprint showing SAI calculation.

SAI = A/B

RESULTS

Table 1: Paired t-test for SAI.

Parameters	N	Mean	SD	SEM	t-value	df	Sig. (2 tailed)
Right SAI	360	0.63	0.18	0.01	3.196	359	0.002
Left SAI	360	0.61	0.19	0.01			

N- Sample size; SD- Standard Deviation; SEM- Standard Error of Mean; t- paired t-test value; df- Degree of freedom; Sig.-Significance

Table 2: Pearson's correlation test to determine relationship of SAI with age and BMI.

Parameters	Right SAI		Left SAI	
	r-value	Sig. (2-tailed)	r-value	Sig. (2-tailed)
AGE	-0.059	0.263	-0.07	0.183
BMI	0.081	0.125	0.084	0.11

r- correlation; Sig.- Significance

Table 3: Independent t-test to show gender differences in mean SAI

GENDER	t-test for Right SAI			t-test for Left SAI		
	Mean	df	Sig. (2-tailed)	Mean	df	Sig. (2-tailed)
MALE	0.65	358	0.061	0.69	358	0.1
FEMALE	0.61			0.59		

t- Independent t-test value; df- Degree of freedom; Sig.-Significance

Table 4: Cross tabulation to show percentages of different foot types

Foot	MALE (n=180)			FEMALE (n=180)			TOTAL (360)			X^2 value	Sig
	NF	PC	PP	NF	PC	PP	NF	PC	PP		
Right (%)	45	12.2	42.8	47.8	16.7	35.6	46.4	14.4	39.2	2.579	0.275
Left (%)	45	18.9	36.1	45	18.9	36.1	45	17.8	37.2	0.3369	0.831

x^2- Chisquare value;Sig.- Significance

Table 5: Chi-square test.

RIGHT FOOT			LEFT FOOT		
X^2 Value	df	Asymp. Sig. (2-sided)	X^2 Value	df	Asymp. Sig. (2-sided)
38.519	22	0.016	49.389	22	0.001

×2- Chisquare value; df- Degree of freedom; Sig.-Significance

Table 6: Cross tabulation to show unilateral and bilateral percentages of different foot types

	FOOT TYPE		LEFT FOOT			TOTAL
			NF	PC	PP	
RIGHT FOOT	NF	Count	128	24	15	167
		Percentage	35.60%	6.70%	4.20%	46.40%
	PC	Count	11	40	1	52
		Percentage	3.10%	11.10%	0.30%	14.40%
	PP	Count	23	0	118	141
		Percentage	6.40%	0.00%	32.80%	39.20%
	Total	Count	162	64	134	360
		Percentage	45.00%	17.80%	37.20%	100%

Fig. 2: Line graph showing mean SAI values of different age groups of right and left feet.

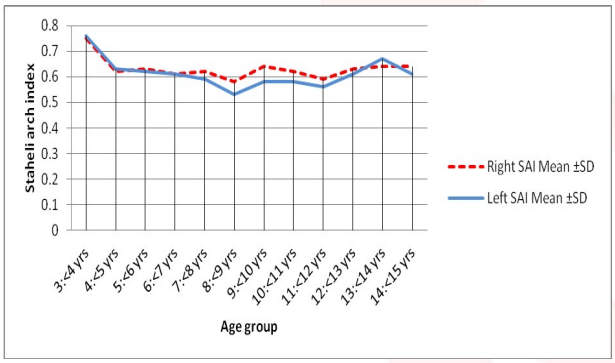


Fig. 3: Age wise percentage prevalence of different foot types of right foot.

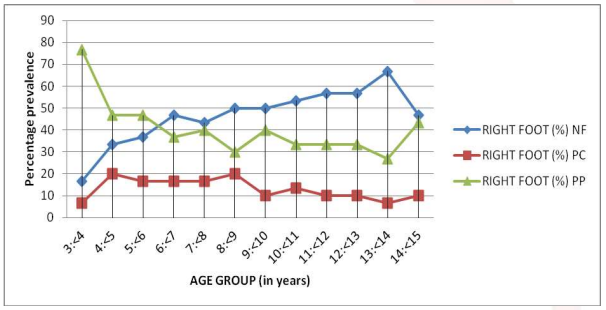
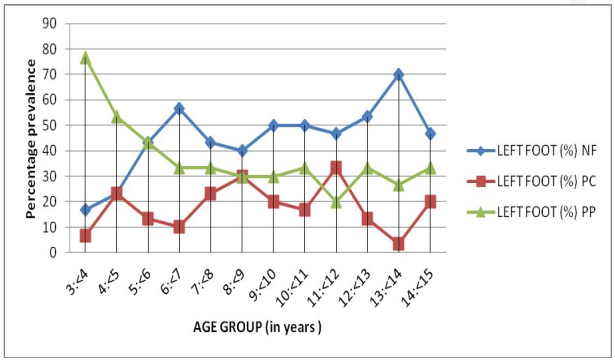


Fig. 4: Age wise percentage prevalence of different foot types of left foot.



DISCUSSION

The aim of this study was to find out foot arch structure in JH tribals of 3-15 year age group using SAI method. The assessment of foot arch was based on footprints. Tribal children unlike the urbans, live close to the natural habitat. Their feet were less likely to be affected by modern footwear. This was the reason to take up study on these subjects as they were considered as true representatives of that population. The study subjects were partially shoe wearers. School going children wear shoes only during school hours. Rest of the time they prefer bear foot walking.

3-15 year age group is the crucial age in the progressive formation of MLA. To delineate different foot types SAI method was used to compare the central and posterior regions of footprints [4].

Mean SAI was 0.63 and 0.61 for right and left foot respectively. Mean SAI values of this study were suggestive of NF type. Significant mean differences between right and left feet were noted using paired t-test. Mean of right SAI was greater compared to left side (Table-1).

The mean SAI values of this study were in close account with the results obtained by Hernandez et al in 5-9 year children as 0.61-0.67 [5]. They even found significant differences in mean SAI of both feet.

Shariff et al noticed bilateral differences in foot arches calculated using SAI in 309 adult women [7]. In a study conducted by Bhattacharjee et al on 3-6 year age group children of South 24 Parganas, West Bengal, found no significant bilateral differences in SAI [8].

Mean SAI values for right and left feet of all age groups were shown in figure-2. Mean right SAI for 3:<4 years was 0.75±0.17 and left SAI was 0.76±0.19. Mean SAI for 14:<15 years age was 0.64±0.19 right and 0.61±0.14 left. A decrease in SAI values from 3:<4 years to 14:<15 years of age for both feet was noted. Both right and left mean SAI values decreased to a maximum by the age of 8:<9 years. Increase in SAI values with slight difference in mean were noted later on till 14:<15 years age.

Children's feet contain a high degree of carti-

lage and plantar pad of fat making them more pliable and easier to change shape by external pressure. Child learns to stand and walk by the 1.5 years of age. As the child walks, fat dissolute and the foot arch structure is visualized. Change in the arch was minimal, when once the adult foot arch condition was attained. By 15-20 years of age the foot bones complete their ossification. Due to this reason there were minimal changes noted in SAI values after 8:<9 years of age (Figure-2).

SAI values were negatively correlated with age and positively with BMI. The correlation coefficient between them was not statistically significant as shown in (Table-2).

Abaragou et al was of the same opinion that the association between age and flatfoot was not statistically significant [9].

Contrary to this, Sharrif found significant correlation between SAI and BMI [7]. They found that both flat foot and high arch prevalence increased with increase in BMI. Hazza et al [10] observed that overweight boys have the highest risk for flat foot. Vijayakumar et al [11] noticed the increase in prevalence of the PP with increased BMI.

Negative correlation of SAI values was an indicative of the age wise development in MLA towards maturity [4]. In the current study, none of the children were of overweight. This could be a reason why this study may not correlate with the findings of Hazza et al [10] and Vijayakumar et al [11].

Gender differences in mean SAI were not significant (Table-3). Similar to this was the study of Bhattacharjee who did not find gender differences in SAI [8]. Hernandez et al reported insignificant gender differences in SAI of 5-9 year age group children of Sao Paulo city of Brazil [5]. Contrary to this, many studies in the literature showed significant association of SAI with gender. Ezema et al also reported significant gender differences in SAI [12]. Hazzaa et al [10] in their study on 8-14 year old Egyptian children noted that SAI significantly correlated with gender but not with age.

Incidence of normal foot (NF) was observed in 45% males for both feet in JH tribal children. In case of females, NF percentages were 47.8% and 45% for right and left feet respectively. PP percentages were 42.8% and 36.1% in males, while 35.6% and 36.1% in females for right and left feet respectively. PC was observed in 12.2% and 18.9% males and 16.7% and 18.9% females for right and left feet respectively (Table-4). The percentage PP was astonishingly high because all these results were indicative of foot arch in WB condition only.

In case of JH 76.7% of 3:<4 years children were observed to have PP. These values reduced to 33.3% and 43.3% by the age of 14:<15 years for right and left foot respectively.

NF was found in 16.7% cases and PC was noted in 6.7% cases at 3:<4 years of age. By the age of 14:<15 years these values of NF increased to 46.7%. PC values rose to 10% and 20% for right and left foot respectively (Figures-3&4).

Prevalence of paediatric PP varies in the literature from 3:<15 years of age due to variable samples, assessment measures and different age groups. Bhattacharjee noticed 57.5% PP among West Bengal children of 3-6 years age [8]. Enrique et al noticed 15.7% PP prevalence in 3-10 year old children of Bogota and Barranquilla [13]. Umar et al [14] recorded 25% PP in 9-14 year children of Yoruba ethnic group, Nigeria. In case of Hausa ethnics of Nigeria, 10% PP was observed by Umar et al in 9-14 year children [15]. Ceron et al noted 12.1% PP in 9-11 year children of Tampico city, Mexico [16].

These studies reported lower PP percentages compared to this study. This difference could be due to the fact that MLA would attain the adult nature by the age of 6-10 years. The children in these studies were of 9-14 years whereas in the current study the children age ranged from 3-14 years. Presence of plantar pad of fat, immaturity of MLA due to ligament laxity might have contributed to the higher PP percentages in our study. In an Indian study conducted by Bhattacharjee the higher PP percentages were suggestive of very young children [8].

Chi-square analysis showed significant differences in incidence of foot types for different age groups in overall study population (Table-5).

By using cross tabulation, bilateral NF percentages were noted to be 35.6% in overall study population. Bilateral PP was 32.8% and PC was

11.1%. This association between right and left foot for different foot types as found statistically significant (Table-6).

CONCLUSION

This study concludes that the SAI decreases with increasing age. However, there was no significant correlation of SAI with age and gender. Bilateral differences in mean SAI were significant. In this study, NF percentages were more compared to other foot types. PP percentages noted in this study were higher compared to other studies. Two reasons might be a cause for this difference. One factor being the age group where the study comprised of 3-14 year children. Second factor being calculation of foot arch based only on weight bearing footprints. This limits this study from differentiating flexible from rigid foot types.

ABBREVIATIONS

SPSS- Statistical Package for the Social Sciences
SAI- Staheli's Arch Index
MLA- Medial longitudinal arch
PP- Pes planus
PC- Pes cavus
JH- Jharkhand
BMI- Body Mass Index
NF- Normal foot

Conflicts of Interests: None

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