

Assessment of Foot Shape in Adult Females of Bangalee and Chakma Ethnic Groups

Sharmista Bhattacharjee^{1*}
Md. Ashrafuzzaman²
Shraboni Chakraborty³

¹Department of Anatomy
Marine City Medical College
Chattogram, Bangladesh.

²Department of Anatomy
Chattogram Medical College
Chattogram, Bangladesh.

³Raozan Upazila Health Complex
Chattogram, Bangladesh.

Abstract

Background : Foot morphology differs among ethnic groups. Proper knowledge of population specific variations are necessary for industrial design and forensic investigations. The study was aimed to measure the foot and determine the foot shape of adult Bangalee and Chakma females to find out and compare any ethnic variation.

Materials and methods: The study was conducted on 200 Chakma and 200 Bangalee adult females. Foot length and foot breadth were measured by slide caliper. Foot index was calculated and foot shape was determined from foot index.

Results: Mean value for length, breadth and index of foot were significantly higher in Chakmas than Bangalees. Percentage of slender foot was higher in Bangalees and broad foot shape was found more in Chakmas. Most of the participants of these two groups have standard foot shape.

Conclusion: Bangalee and Chakma adult females showed differences in structural characteristics of foot which may be attributed to their ethnicity and environment.

Key words: Foot shape; Bangalees; Chakmas.

INTRODUCTION

Foot is a complex structure that consists of bones, muscles, ligaments and joints. Shape of the foot differs among individuals as a result of age, gender, ethnicity and environment^{1,2}. Distribution of the internal foot structure serves as an indicator of ethnic identity, age and gender of a deceased person in forensic investigations. Assessment of foot structure and shape is required for proper designing of footwear prosthetics and orthotics^{1,3}. Foot shape and function is affected by weight bearing, obesity and habitual use of footwear or barefoot walking. Deviation from normal shape causes mechanical imbalance that may lead to injury of foot^{4,5,6}.

The Bangalees are the largest ethnic group of Bangladesh and they are of mixed ethnic origin. The Chakmas are the second largest ethnic group after the Bangalees. This Mongoloid ethnic group resides mainly in the Chattogram Hill Tracts where as the Bangalee population is distributed throughout the country^{7,8}. There is limited foot morphometric data on the Chakma and the Bangalee females of Bangladesh at present despite its importance. So, the focus of the present study is to provide basic information regarding the foot shapes of the two ethnic groups and to find out any existing ethnic variation.

MATERIALS AND METHODS

This cross sectional and study included 200 Bangalee and 200 Chakma adult females of 18 to 44 years of age from Chattogram city. Anyone with a history of operation or deformity of lower limb, any genetic, endocrine or neurological disorders were excluded from the study. The selected subject was asked to stand with her heel together and to keep her back as straight as possible so that her heels, buttocks,

*Correspondence to:

Dr. Sharmista Bhattacharje
Assistant Professor
Department of Anatomy
Marine City Medical College
Chattogram, Bangladesh.
Mobile: +88 01715 50 18 60
Email: sharmista201@gmail.com

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shoulders touched the wall. The stature was then measured in centimeters with measuring tape⁴. Weight was measured with an analogue weighing machine. Then BMI was calculated as kg/m². If BMI was between 18.5 and 24.9, each participant was measured for right and left feet. The data for the both feet were pooled for statistical analysis of foot variables. Foot Length (FL) was measured from the posterior prominence of the heel to the tip of the longest toe⁹. Foot Breadth (FB) was measured as the distance between the most medial point on the head of the first metatarsal to the most lateral point on the head of the fifth metatarsal⁹. A manual sliding caliper was used to measure all the foot dimensions. Foot Index (FI): FI was calculated for each individual by dividing the foot breadth by the foot length $\times 100$ ⁹. Three types of foot shapes were determined according to the foot index.

i. Slender foot: $FI^* < FI - SD$

ii. Standard foot: $FI - SD < FI^* < FI + SD$

iii. Broad foot: $FI^* > FI + SD$

(FI^* - Individual foot index, FI - Mean foot index, SD- Standard Deviation)

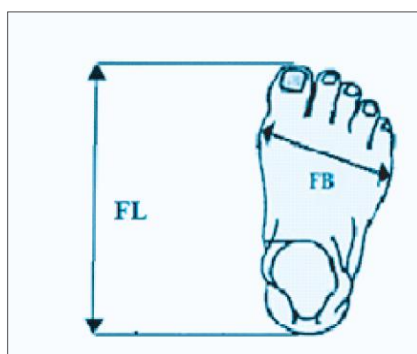


Figure 1 : Diagrammatic representation of selected foot measurements

(Source: Modified from Parham et al¹⁰)

* FL-Foot Length, FB-Foot Breadth.

RESULTS

Table I : Comparison of demographic characteristics of Bangalee and Chakma ethnic groups

Variable	Bangalee (n=200)		Chakma (n=200)		t value	Significance (2 tailed)
	Mean	SD	Mean	SD		
Age (Yr)	27.46	7.36	26.24	8.1	1.5765	0.1157 NS
Height (cm)	155.03	5.41	155.45	4.78	0.8228	0.4111 NS
Weight (Kg)	50.69	6.08	49.97	6.78	1.1181	0.2642 NS
BMI (Kg/m ²)	21.46	2.08	21.06	2.38	1.7897	0.0743 NS

BMI- Body Mass Index, NS- Not Significant.

Table I showed the mean values and standard deviations of age, height, weight and BMI of both groups. In all the four categories, differences between means were not significant. So, the study groups were homogenous.

Table II : Comparison of foot variables between Bangalee and Chakma adult females

Variables	Bangalee (n=200)		Chakma (n=200)		Differences of means between study groups	SED	t value	Significance (2 tailed)
	Mean	SD	Mean	SD				
FL (cm)	22.91	0.79	23.11	0.78	-0.2021	0.078	2.5127	0.0124*
FB (cm)	8.55	0.40	9.22	0.48	-0.6708	0.044	15.1729	0.0001***
FI	37.35	1.92	39.94	2.23	-2.59	0.208	12.4293	0.0001***

FL-Foot Length, FB-Foot Breadth, FI-Foot Index, SD-Standard Deviation, SED-Standard Error of Differences Between means:cm-centimeter.

● ($p > 0.05$) = Not significant, ($p < 0.05$)* = Significant, ($p < 0.001$)*** = Highly significant.

Table II presents the comparative analysis of foot variables between Bangalee and Chakma adult females. The foot length was higher among the Chakmas (23.11 ± 0.78 cm) than the Bangalees (22.91 ± 0.79 cm). The difference between the two groups was statistically significant. The mean foot breadth was 9.22 ± 0.48 cm for the Chakmas and 8.55 ± 0.4 cm for the Bangalees. The mean breadth was higher among the Chakmas and the difference was highly significant ($p < 0.001$). Similarly, foot index value for Chakmas (39.94 ± 2.23) was higher than the Bangalees (37.35 ± 1.92) and the difference between means was highly significant ($p < 0.001$).

Table III : Distribution and comparison of the participants by shapes of foot

Foot Shape	Bangalee (%)	Chakma (%)	χ^2	Significance
Slender	17.5	15.5	5.25	0.0724 NS
Standard	68	67.5		
Broad	14.5	17		

● ($p > 0.05$) = Not significant (NS)

Table III shows the percentage distribution of Bangalee and Chakma females according to foot shape. The percentages of slender and standard foot was higher among the Bangalees (17.5% and 68%) than the Chakmas (15.5% and 67.5%). The Chakmas (17%) had higher percentages of broad foot than the Bangalees (14.5%). The differences in percent distribution of Bangalee and Chakma females at three foot shape categories were not statistically significant. So, Bangalee females do not differ significantly from their Chakma counterparts regarding foot shape.

DISCUSSION

Manna et al conducted a study on 100 Bangalee female in the age group of 25-35 years, residing at West Bengal in India¹¹. The reported right foot length and breadth was 22.98 ± 1.44 cm and 8.55 ± 0.31 cm respectively. Their findings are similar to that of the Bangalee females of Bangladesh. Another study on 600 adult Punjabi women in the age range of 18-60 years found

that right foot length and breadth were 23.14 ± 1.11 cm and 8.65 ± 0.45 cm respectively¹². The mean foot length and breadth for Bangalees in the present study was less than that of Punjabi women. But foot index value for Punjabi women (37.42 ± 1.63 cm) was similar to that of the Bangalees. It suggested a similarity in proportion despite the differences in mean values of foot length and breadth.

Suakabkaew et al conducted a study on 250 Thai females of 20-50 years of age and their right foot length and breadth were 23.17 ± 0.99 cm and 9.3 ± 0.5 cm¹³. It is similar to that of the Chakma females of the present study as both groups are Mongoloid in ethnicity. Xiong et al. worked on 24 Hong Kong Chinese women with mean age of 22.46 ± 2.5 years¹⁴. Their reported foot length and foot breadth were 23.24 ± 0.86 cm and 9.03 ± 0.48 cm respectively. Chakma females had smaller and broader foot than the Hong Kong Chinese. Shoe wearers such as Hong Kong Chinese women tend to have narrower feet than sandal wearers or barefoot walkers like the Chakmas⁶. Kouchi observed that the mean values for foot index in Japanese, Australian aborigine, French and Indonesian females were 41.0, 38.2, 38.6 and 40.8 respectively¹⁵. The foot index value for the Chakmas are more similar to that of the Japanese and Indonesian than the Australian aborigine and French.

According to the findings of the present study, the Chakma females have higher mean values for foot length, foot breadth and foot index than their Bangalee counterparts. The greater foot index in Chakmas indicates wider feet for a given foot length than the Bangalees. This finding is in agreement with Kouchi who observed that Mongoloid populations tend to have a wider foot for foot length¹⁵. The Chakma females also have higher percentage of broad foot shape whereas the Bangalees have greater percentages of slender and standard foot shape. The larger dimensions of foot in Chakma females are suggestive of increased surface area as a result of genetic adaptation to temperature stress in the warmer climate of the Chattogram Hill Tracts¹⁶.

CONCLUSION

The Chakma females have larger dimensions of foot than their Bangalee counterparts which may be attributed to their ethnicity and environment. It is of great importance to identify the variations of foot morphological characteristics among different ethnic groups for the successful design of commercial products such as footwear, prosthetics and orthotics for specific ethnic group. The knowledge of population specific variations are also required in forensic investigations to establish ethnic identity.

DISCLOSURE

All the authors declared no competing interest.

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