

Correlation of Stature with foot Breadth at Ball and Heel from Footprint of Bangladeshi Male Medical Students

Farhana Hossain¹, Shamim Ara², Nahid Shahana³, Sadia Rahman⁴, Rawshon Naznin⁵, Umma Morium⁶, Farzana Maqsood⁷

Abstract

Context: Footprint is the impression of the sole of the foot on an even flat ground or surface which provides the dimensions of size of the plantar surface of the foot actually touching the floor or a hard surface. Assessing the height of an individual from the measurements of different dimensions of foot has always been of immense interest to anatomists, anthropologists, podiatrists and industrialists involved in designing foot wears. As ossification of the bones of the foot occurs earlier than the long bones of the lower extremity, therefore even during adolescence, stature can be predicted more accurately from foot measurements than that from the long bones of the lower limb. Therefore, it has been shown that the reliability of prediction of stature from foot dimensions is as high as that from long bones.

Materials and methods: A cross sectional analytical study was carried out at the Department of Anatomy, Dhaka Medical College Dhaka, from July 2012 to June 2013. The study was conducted on 200 male medical college students of 18-25 years of age who were selected from different medical colleges of Dhaka city and their age was determined by their national ID card. Height of the students were recorded with the help of the stadiometer. To take footprint, the sole of the feet were painted with stamp pad ink. The study was planned to determine the foot breadth at ball and heel from footprint of the male Bangladeshis and to find out the correlation of stature of Bangladeshi male medical students with their foot breadth at ball and heel from footprint.

Results : Significant differences were observed between breadth at ball and heel of right and left foot ($P < 0.001$). Breadth at ball of left foot was greater than the right foot but breadth at heel was greater on the right foot than the left foot. There was highly significant correlation between stature and the breadth at ball and heel of right and left foot ($P < 0.001$).

Key Words: stature, foot breadth

Introduction :

Every part of human body is unique in itself as every part of the body is different in its own way from a similar part in another body. There is also a

relationship between each part of the body and the whole body. Footprint is the impression of the sole of the foot on an even flat ground or surface which provides the size dimensions of the plantar surface of the foot actually touching the floor or a hard surface.

Footprints are of immense value in establishing personal identity of the criminals in forensic examinations. The partial or complete footprints can be found on rain covered areas, newly waxed floors, freshly cemented surfaces, moistened surfaces, in dust, mud, sand, oil, paint and can be left in blood at the crime scenes.¹ The foot dimensions derived from footprint can provide definitive information on many physical characteristics of the individual as morphology of

1. Assistant Professor, Department of Anatomy, Bangladesh Medical College, Dhaka
2. Professor and Head of the Department, Department of Anatomy, Dhaka Medical College, Dhaka
3. Professor, Department of Anatomy, Bangladesh Medical College, Dhaka
4. Assistant Professor, Department of Anatomy, Ibrahim Medical College, Dhaka
5. Assistant Professor, Department of Anatomy, US Bangla Medical College, Rupganj
6. Assistant Professor, Department of Anatomy, Ashiyan Medical College, Dhaka
7. Lecturer, Department of Anatomy, Bangladesh Medical College, Dhaka

Correspondence : Dr. Farhana Hossain

human foot shows variations due to the combined effects of heredity, lifestyle and climatic factors.²

Stature is the height of the person in the upright posture. It is an important measure of physical identity. Establishing the identity of an individual from mutilated, decomposed and amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal and humanitarian reasons. "Stature" is one of the most important elements in the identification of an individual.¹

Dimensional relationships between the body segments and the whole body have been of interest to artists, scientists, anatomists, anthropologists and medicolegal experts for long time.² Examination of skeletal remains recovered from a scene of crime, have often been used by the forensic anthropologists to extract relevant information about the victim. One such aspect pertains to reconstruction of living stature from such skeletal remains.³

The importance of naked foot marks has been noticed and utilized from very early times. In the famous case of LeDru, the identification of a criminal through footprint was utilized as early as 1888. Foot or shoe prints, if present at the scene of crime, may provide clue regarding the stature of the person which may help in establishing partial identity of the suspect. Moreover, in an aircraft accident it is the feet, which are recovered more intact than other parts of the body, as they are often shoe clad.⁴ As ossification of the bones of the foot occurs earlier than the long bones of the lower extremity, therefore even during adolescence, stature can be predicted more accurately from foot measurements than that from the long bones of the lower limb.⁵ This would enable forensic scientists to solve crimes in the absence of complete evidence and the anthropologist and archeologist to analyze events that occurred in remote past.⁶

The stature was estimated from skeleton by anatomical method which was introduced by

Dwight in 1894.⁷ The vertical height of a person needs an equally firm base to support it, which is provided by feet.⁸ This provides information that increase in height is associated with an increase in foot dimensions. The foot has been used to estimate stature in several studies in different tribal groups, where normograms have been derived to reconstruct stature from foot dimensions. These types of studies in different communities become essential, as several factors which include genetic and environmental, are known to affect stature and foot morphology as well as dimensions.⁹

The present study includes foot breadth at ball and heel of footprint rather than taking length and breadth only as have been done in most of the previous studies. So, the study will be applicable not only to complete footprint measurement but also to partial footprint in estimation of stature. With the above perspective, the present study was carried out to correlate the foot breadth at ball and heel with stature of the 18-25 years age group of Bangladeshi males.

Materials and Methods :

This cross sectional analytic study was carried out at Department of Anatomy of Dhaka Medical College, Dhaka from July 2012 to June 2013. Two hundred (200) male medical college students of 18-25 years of age were selected from Dhaka Medical college, Bangladesh Medical College and Ibn Sina Medical College of Dhaka city and their age was determined by their national ID card. Prior to this, permission from the head of the institutes or phase 1 coordinator of the respective medical colleges was taken to carry out the study procedure. Informed written consent was taken from each subject. The study was approved by the Ethical Review Committee (ERC) of Dhaka Medical College.

Stature of the students were recorded with the help of the stadiometer. The feet of the individual were then washed with liquid soap before inking. Feet were washed to remove oily or greasy substance and dirt from the foot. The feet were then wiped with a towel. Two legal size white papers were fixed on a clip board with double clips to take print of right and left foot which was placed on an even

floor as footprints of both feet were collected at the same time. A small amount of ink was poured into a clean and dry flat box with a wide base. The individual was asked to sit on a chair and rest his legs on a low stool with extended knee so that his feet were placed beyond the stool for proper painting of the soles. A wide paint brush was moved in the ink over flat surface of the wide based box until the ink spread thinly and homogenously in the brush.

The right and left foot were painted with ink with the help of the brush. After ensuring that toes and sole were inked properly, footprints were taken at the same time for both foot while the ink was still wet. The feet were carefully removed from the stool and the soles were placed slowly on the paper from proximal to distal end while the individual still remained seated. The individual was then asked to stand from sitting position with his feet placed on the papers on the clipboard without moving the feet. After ensuring that the feet were placed properly the individual was asked to stand erect without any support while putting equal pressure on both foot without moving their position on the papers. The individual was then asked to sit. The feet were then lifted from the paper at the same time so that there was no overlapping of the already imprinted footprint. A sharp 2B lead pencil was used to mark the most prominent points of the ball and heel of the foot.

Foot breadth at ball was measured from footprint as a distance between the medial side of the head of the first metatarsal, that is, the most prominent part of the inner side of the ball of the foot and the lateral side of the head of the fifth metatarsal, that is, the most prominent part of the outer side of the ball of the foot. Foot breadth at heel was measured from the most prominent part of lateral side of the heel to the most prominent part of medial side of the heel. The vernier digital spreading caliper was placed horizontally on the landmarks and all the measurements were taken in centimeter.

For statistical analysis, SPSS version 16 was used. The relationship between the right and left footprint measurements were determined by paired t- test (Table I). Stature was correlated with the footprint by Pearson's correlation coefficient test (Table II).

Ethical Clearance:

The study was approved by Ethical Review Committee of Dhaka Medical College, Dhaka.

Results :

Table 1

Breadth at ball and heel of right and left footprint of adult Bangladeshi male medical students

Foot variables	Breadth (cm)		P value
	Right foot (n=200) Mean±SD	Left foot (n=200) Mean±SD	
Breadth at ball	8.88±0.55 (7.15 10.66)	9.06±0.58 (7.70 10.77)	0.0001***
Breadth at heel	5.00±0.45 (3.72 6.53)	5.06±0.43 (3.70 6.37)	0.004**

Figures in parentheses indicate range. Comparison between right and left foot done by paired Student's 't' test, ** = significant at P<0.01, *** = significant at P<0.001

Table-II

Relationship between stature and breadth at ball and heel of right and left footprint of Bangladeshi male medical students

Foot variables	Right foot (n=200)		Left foot (n=200)	
	P value	r value	P value	r value
Breadth at ball	+0.353	0.0001***	+0.357	0.0001***
Breadth at heel	+0.330	0.0001***	+0.308	0.0001***

Pearson's correlation coefficient (r) test was performed to compare relationship between parameters, *** = significant at P<0.001

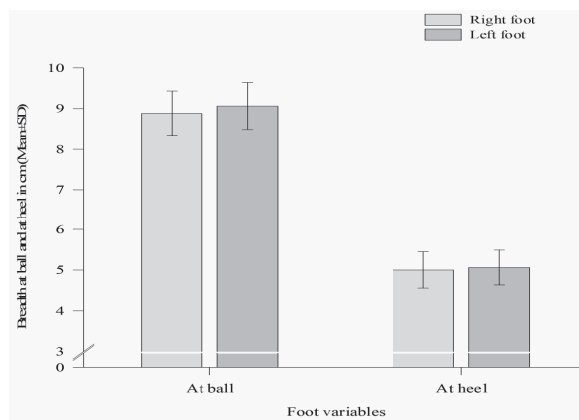


Fig 1 : Breadth at ball and heel of right and left footprint of Bangladeshi male medical students

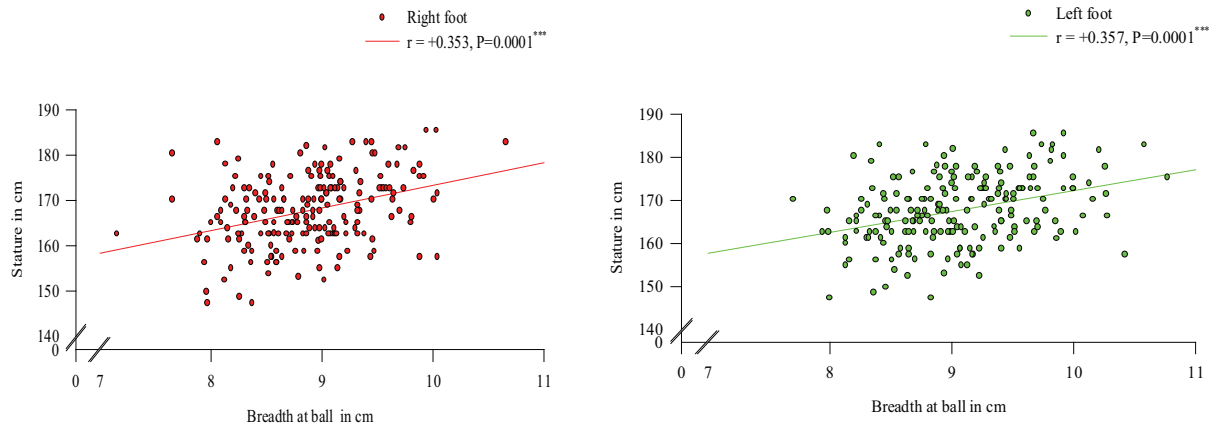


Fig.-2 : Relationship between stature and breadth at ball of right and left footprint of Bangladeshi male medical students

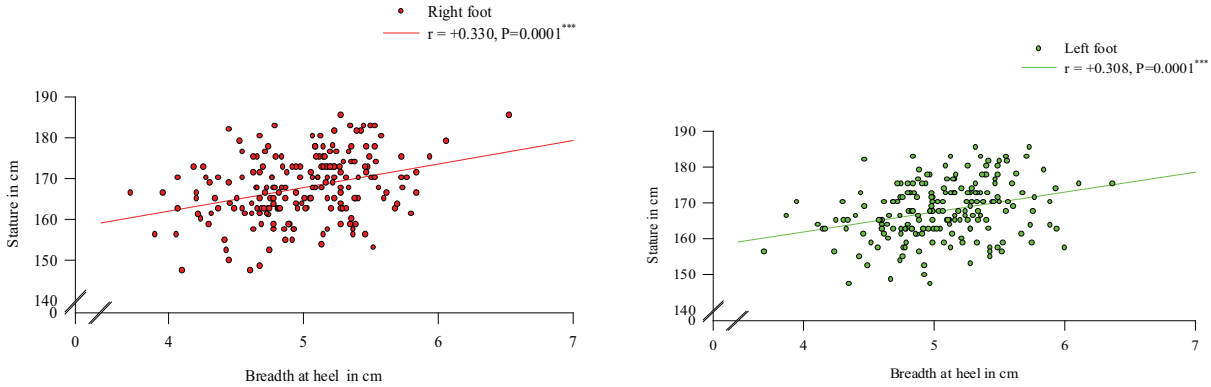


Fig.-3 : Relationship between stature and breadth at heel of right and left footprint of Bangladeshi male medical students

Discussion:

The present work was undertaken to find out the correlation of stature with foot breadth at ball and heel from footprint of Bangladeshi males. The findings of this study were statistically analysed and revealed important information about variations in foot dimensions of Bangladeshi males.

In the present study, significant differences were observed between breadth at ball and heel of both feet ($P < 0.001$). Breadth at ball and heel of left foot was greater than the right foot. The breadth at ball of both feet reported by Kewal Krishan^{2,3} in 2008 were significantly lower than the findings of the present study ($P < 0.001$). Breadth at heel of right foot was significantly lower than the findings of the

present study ($P < 0.001$) but in left foot it was not significant with the present study ($P > 0.05$). Correlation of stature with foot breadth at ball and heel from footprint were highly significant ($P < 0.001$) as reported by Kewal Krishan.²

Breadth at ball and heel of left foot was greater than the right foot in the study carried out by Robbins LM (1986).¹ Breadth at ball and heel of her study were significantly lower than the findings of the present study ($P < 0.001$) on the left foot but were not significant on the right foot with the present study ($P > 0.05$). Dissimilarities might be due to the use of an age group with a wide range of population which included children, adolescents, adults and elderly and admixture of different races.

Robbins LM¹ also stated that correlation of stature with foot breadth at ball and heel from footprint were highly significant ($P < 0.001$).

The reason of dissimilarities with those of Kewal Krishan² might be due to racial variation as he used sample from tribal population who are mostly engaged in the agricultural work all the time, putting more strain on their feet while working in the fields and therefore it is most natural that the foot is more used for walking or weight bearing becomes physically better developed. Another reason of dissimilarity is also supported by Rao and Kotian, cited by Kewal Krishan² as they suggested that the difference between left and right footprints in the same individual is not a coincidence but may be explained on the basis of the "dominant foot". Most of the individuals have dominant foot, usually the left one, which always support the body to a greater extent while in standing or in walking. The shoe of this foot wears off at a faster rate than the shoe on the other foot. The bones in the dominant foot are regularly subjected to stronger stress forces like weight bearing pressures, than the bones of the other foot. This in turn enlarges the bones of the dominant foot and therefore produces a footprint of larger dimension.

In the present study, correlation of stature with foot breadth at ball and heel from footprint were highly significant ($P < 0.001$).

Conclusion:

In the present study, there was a strong correlation between the stature and breadth at ball and heel from footprint among Bangladeshi male medical students.

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