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## Original Research

### Gender determination from foot measurements in known population- A Cross-sectional observational study

Jyotsana Kumari<sup>1</sup>, Shamin Raza<sup>2</sup>

<sup>1,2</sup>Assistant professor, Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences Ataria Sitapur, U.P., India

#### ABSTRACT

**Introduction:** In cases of mass explosion and disasters it becomes difficult for forensic experts to identify the individuals as most of the times body gets mutilated. As various parts of human body grow in proportion to each other, relationship amongst them can be established. Due to variation in size of feet, foot size can also be used to differentiate between males and females. **Materials and Methods:** A Cross-sectional observational study was conducted on 200 individuals (100 males and 100 females) above 18 years of age in the Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences Ataria Sitapur, U.P. The foot length and breadth were calculated with the help of a sliding vernier calliper. The foot index for both genders is derived by dividing the foot breadth by foot length and multiplying it by hundred. The data was collected, analyzed and subjected to statistical analysis. **Observations & Results:** The mean value of right foot index in males and females was 38.32 and 37.44 respectively. The mean value of left foot index in males and females was  $38.01 \pm 2.21771$  and 37.05 respectively. Foot Index showed a statistically significant difference between males and females as p value was found to be below 0.05. **Conclusion:** Males have a longer and wider foot as compared to females. Significant difference in the size of foot amongst both sexes makes it as an important part of human identification.

**Key words:** foot index, forensics, sex determination.

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**Corresponding author:** Dr. Shamin Raza, Assistant professor, Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences Ataria Sitapur, U.P., India

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#### INTRODUCTION:

Identification is often required in medico-legal practice. The problem mainly arises when the body is recovered in advanced stage of decomposition, mutilated state and skeletanized state.<sup>1</sup>

Determination of sex is one of the important parameters, especially when cases of mutilated body parts are brought to the forensic department. Every individual is unique and have different dimensions of their body parts which grow in proportion to each other. Such anthropological studies can facilitate the law enforcement authorities in simplifying the identification technique.<sup>2</sup>

The human foot, the foundation of bipedal locomotion, is a highly complex multi bone structure with 26 bones and numerous articulation.<sup>3</sup> It shows

variations in different dimensions due to genetic and environmental factors.<sup>4</sup> The morphology of human feet is greatly influenced by combined effects of heredity and living style. These determine the size and shape of the feet and footprints and thereby making those unique data to establish human identity.<sup>5</sup>

In the present study, attempt has been made to differentiate between males and females on the basis of foot measurements.

#### MATERIALS AND METHODS:

A Cross-sectional observational study was conducted on 200 individuals (100 males and 100 females) above 18 years of age in the Department of Forensic Medicine and Toxicology, Hind Institute of Medical Sciences Ataria Sitapur, U.P.

In our study, the sample included only the students above the age of 18 years, as above this age, most people attain their maximum growth and therefore their maximum foot length and breadth.<sup>1</sup>

Exclusion criteria: The subjects with any apparent physical foot anomalies, inflammation, surgery, trauma, orthopedic deformities, metabolic or developmental disorders were excluded.

Ethical clearance was obtained from the ethical clearance committee and prior informed consent of the study was obtained from all the subjects in writing.

**Measurements:**

The measurements were taken with the help of vernier caliper; foot length on both sides was obtained by taking the percutaneous measurement between the most prominent posterior and anterior part of the foot while breadth was obtained by percutaneous measurement of the most prominent medial and lateral side of foot. Then, foot Index was calculated by dividing the maximum breadth by maximum length of foot and multiplying by 100 (Foot Index = Foot breadth / Foot length x 100).

This data was collected, analyzed and subjected to statistical analysis using statistical package for the social sciences (SPSS).

**RESULTS:**

The foot length and breadth on both sides was greater in males as compared to females. Both these parameters showed statistically significant difference. (Table 1).

**DISCUSSION**

Forensic anthropological investigations heavily rest upon morphological analyses. Anthropologists are usually very successful in determining the sex through this method. But this method necessitates ample experience and is considered to be subjective by. Reliability of this method is proportionate to the amount of body extremities available. In many criminal cases, disasters, and accidents, the body parts may not always be available for the authorities. Forensic experts and forensic anthropologists try,

therefore, to develop methods of determining the sex through smaller body parts. This study, for similar reason, attempts to establish a procedure to determine the sex of a dismembered body through foot measurements.<sup>6</sup>

The human foot, the foundation for bipedal locomotion, is a complex adaptation that evolved through extensive remodeling of the hind appendage of the human arboreal primate forebears. The normal human foot shows great individual variation in length, breadth in males and females.<sup>7</sup>

The current study was carried out to observe sex differentiation by foot dimensions. We found larger dimension in males as compared to females for both right and left side of foot (length and width). Our finding is consistent with the studies done by Agnihotri AK et al<sup>1</sup> in 2006, Tyagi AK et al<sup>8</sup> in 2004 and Bob-Manuel I and Didia B<sup>9</sup> in 2008.

It has been reported earlier too that average male is ten centimeters taller than the average female and this difference will also be translated in an overall trend that males will have greater foot length as compared to females.<sup>10</sup>

In the present study right and left foot dimensions (length and width) showed statistically significant difference amongst both male and female as p value is less than 0.05. This too is consistent with the studies done by Singla R et al<sup>11</sup> in 2015 and Atal DK et al<sup>12</sup> in 2017.

Foot index in the present study were greater in males than females. This is in concordance with earlier study done by Danborn B and Flukpu A<sup>13</sup> in 2008 who observed that Foot index is more in males than in females. However Singh R et al<sup>2</sup> in 2019 reported higher foot index in females than in males. Apart from variation due to ethnicity and diversity of people residing in different locations, these differences in foot measurements among males and females could also possibly be due to physical activities, hormonal effect or type of foot wear.<sup>1</sup>

Foot	Parameter	Sex	Mean	Std. Deviation	P value	Significance
RIGHT	Length	M	25.96	0.12	0.00	HS
		F	23.85	0.14		
	Breadth	M	8.91	0.22	0.00	HS
		F	8.11	0.21		
	Index	M	38.32	0.11	0.002	HS
		F	37.44	0.19		
LEFT	Length	M	25.83	0.13	0.001	HS
		F	23.43	0.22		
	Breadth	M	8.82	0.19	0.00	HS
		F	8.01	0.19		
	Index	M	38.01	0.15	0.002	HS
		F	37.05	0.18		

Table 1: Foot dimensions in both genders

### CONCLUSION:

Males have a longer and wider foot as compared to females. Significant difference in the size of foot amongst both sexes makes it as an important part of human identification. Further researches are needed in this field.

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