

## Sex differentiation by foot measurements in north Indian population

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### Abstract

**Introduction:** Identification of victims from mutilated and disfigured human remains has always been a tedious task for Forensic experts. This problem is encountered in cases of mass disasters, explosion, and assault where body gets dismembered and identity of an individual becomes a challenge. Since, different parts of the human body grows in proportion to each other, relationship amongst them can be easily appreciated. Differentiation on the basis of sex, using foot index as a parameter, significantly contributes in identification.

**Materials and Methods:** A Cross-sectional observational study was conducted on 198 subjects (99 males and 99 females) above 17 years of age in the Department of Forensic Medicine and Toxicology, HIMS, SRHU, Dehradun. The foot length and breadth were calculated with the help of a sliding vernier calliper. The data was collected, analyzed and subjected to statistical analysis using statistical package for the social sciences (SPSS).

**Observations & Results:** The mean value of right foot index in females and males was  $39.5620 \pm 2.99377$  and  $38.286 \pm 2.86062$  respectively. The mean value of left foot index in females and males was  $39.1384 \pm 2.21771$  and  $38.0241 \pm 2.61031$  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. Statistically significant difference in this measurement amongst both sexes makes these foot parameters as one of the integral part of identification, thereby helping the law enforcement agencies.

**Keywords:** Foot Index, Identification, sex.

### Introduction

Identification of an individual especially when decomposed, mutilated and skeletonized bodies are recovered in cases of mass catastrophe and disasters (natural or man-made) becomes a problem for the forensic experts. In the past, numerous studies have been conducted on various dimensions of human body parts in order to estimate stature, race and sex.<sup>1-8</sup> Determination of sex is one of the important parameters, especially when cases of dismembered 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.<sup>6,7,9</sup> Such anthropological studies can facilitate the law enforcement authorities in simplifying the identification technique. The present study is performed to find relationship in foot dimensions amongst both sexes in the north Indian population.

### Materials and Methods

A Cross-sectional observational study was conducted on 198 subjects (99 males and 99 females) above 17 years of age in the department of Forensic Medicine and Toxicology, HIMS, SRHU, Dehradun after obtaining informed consent from the willing participants. Subjects having any skeletal deformity such as in genetic disorders i.e marfan syndrome,

osteogenesis imperfecta, down's syndrome, or any autoimmune disorders like arthritis, hypophosphatemic rickets or disease (osteitis deformans, scoliosis, kyphosis) and amputated feet were excluded. 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. This data was collected, analyzed and subjected to statistical analysis using statistical package for the social sciences (SPSS).

### Observations & Result

The foot length on both sides was greater in males as compared to females. Similarly, foot breadth was also found to be greater in males. Both these parameters showed statistically significant difference, as p value was less than 0.05. However, the value of foot index on both the sides was more in females than males with a statistically significant difference (Table 1).

**Table 1:** Foot dimensions in both sexes

Side	Parameter	Sex	Mean	Std. Deviation	Std. Error Mean	t-value	p-value	Significance level
Right foot	length	M	25.8263	1.02535	.10305	13.049	0.000	Highly significant
		F	23.7566	1.19959	.12056			
	breadth	M	9.8788	.66429	.06676	5.405	0.000	Highly significant
		F	9.3545	.70004	.07036			
	index	M	38.2826	2.68062	.26941	-3.168	0.002	Highly significant
		F	39.5620	2.99377	.30089			
Left foot	length	M	25.8525	1.06161	.10670	12.957	0.000	Highly significant
		F	23.6687	1.29824	.13048			
	breadth	M	9.8182	.61218	.06153	5.934	0.000	Highly significant
		F	9.2768	.67034	.06737			
	index	M	38.0241	2.61031	.26235	-3.237	0.001	Highly significant
		F	39.1384	2.21771	.22289			

## Discussion

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 many of the authors<sup>3-7, 9</sup> Also, 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 many authors<sup>3-7</sup> As in our study, some of the authors<sup>3,4,6</sup> found that foot index on both sides is more in females than males with statistically significant difference as p value is less than 0.05 except in a study by Singla R et al conducted on Rajasthan population and mixed North Indian population. He found that in Rajasthani population foot index is statistically non-significant and in North Indian population it is statistically significant.<sup>5</sup> Another study by Gupta VP and Shah AH<sup>8</sup>, revealed foot index is more in males as compared to females which is not consistent with our result. 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>10, 11</sup>

## Conclusion

Statistically significant difference of foot measurements amongst both the sexes makes it one of the integral parts of identification. The ease, reliability and less time consumption technique, for differentiating sex based on these measurements, not only makes the current study more valuable medico-legally but also facilitates provision of better footwear designs for the Indian Population. Since, there exist differences in an individual's anthropological measurements from one another due to ethnicity and cultural variations. Hence, more studies are required to be facilitated involving larger number of population in different parts of the country so that better correlation and effective application of the study can be achieved.

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