

## Sexual Dimorphism in Foot Length and its Comparison with Height and Weight

Syed Sadiqali Abbasali\*, Herekar N.G.\*\*, Phad V.V.\*\*\*

### Abstract

The study was done to find sexual dimorphism in foot length and to correlate foot length with height and weight. The present study was done on 150 medical college students, 68 males and 42 females of 19-23 year of age. Foot length was determined from foot sketches taken in anatomical position. Height and weight was measured with standard height and weight measuring instrument. It was found that male foot length was proportionately larger than female foot length for given height. There was statistically significant correlation between height and foot length in males and females. Results of present study are helpful for estimation of stature from lower extremity parts and establishing personal identity in forensic sciences.

**Keywords:** Foot length; Forensic science; Height; Stature; Weight.

### Introduction

Human foot has a very complex structure formed by union of tarsals, metatarsals and phalanges. Studies have been done on foot size for improvements in footwear design. Also some studies have been done in forensic science to determine stature from foot length. Many studies documented that in proportion to stature male have larger foot than female. Their exist lots of variation in foot size and it shows sexual dimorphism, which changes with region of study.

Ossification of bones in the foot occurs earlier than long bones so height could be more accurately predicted from foot measurement as compared to that from long bones in adolescence age. In medico-legal cases, estimation of stature from extremities and their parts plays an important role in establishing personal identity. So present

study was undertaken to find out the correlation between foot length with height and weight of an individual and to derive regression formulae to estimate the height from the foot length.

### Materials and Methods

Present study was performed on 150 medical college students, 68 male 82 females of age between 19 years and 23 years. Students having no any physical deformity were selected for the study. By using standard instruments height in centimetre and weight in kilograms, of students were recorded. Foot outline of right and left foot were drawn in normal anatomical position. To find foot length, on sketches, first long axis of foot was determined by joining two points, first most distal point on second toe and second most distal point at the heel end. Line passing through these two points was long axis of foot. Perpendicular was drawn to this axis passing by touching most distal point at front, which may be 1st toe or 2<sup>nd</sup> toe, whichever was longer. Another perpendicular was drawn at most distal point at heel end. The distance between these two perpendiculars was foot

---

**Author's Affiliation:** \*Assistant Professor, \*\*Professor and Head, \*\*\*Assistant Professor, Dept. of Anatomy, Government Medical College, Miraj, Maharashtra, India.

**Reprint's Request:** Dr. Syed Sadiqali Abbasali, Mamta Nursing Home, 39/B, Subhashnagar, Miraj, Maharashtra, India.

E-mail: sadiqalisyed3@gmail.com

**Table 1: Showing Height Groups and Average Foot Length in Males and Females**

Height (Group) (cm)	Mean Height	Average Foot Length Male (cm)	Average Foot Length Female (cm)
140-144	142		20.6
145-149	147		21.8
150-154	152		23.1
155-159	157	23.7	23.1
160-164	162	24.7	23.9
165-169	167	25.6	24.6
170-174	172	26	24.8
175-179	177	26.2	
180-184	182	27.8	

**Graph 1: Comparison of Male and Female Foot Length with Height****Table 2: Showing Weight Groups and Average Foot Length in Males and Females**

length. Foot length was measured in right and left foot and average was drawn which was correlated with height and weight.

### Observations and Results

The observations were done on 68 males and

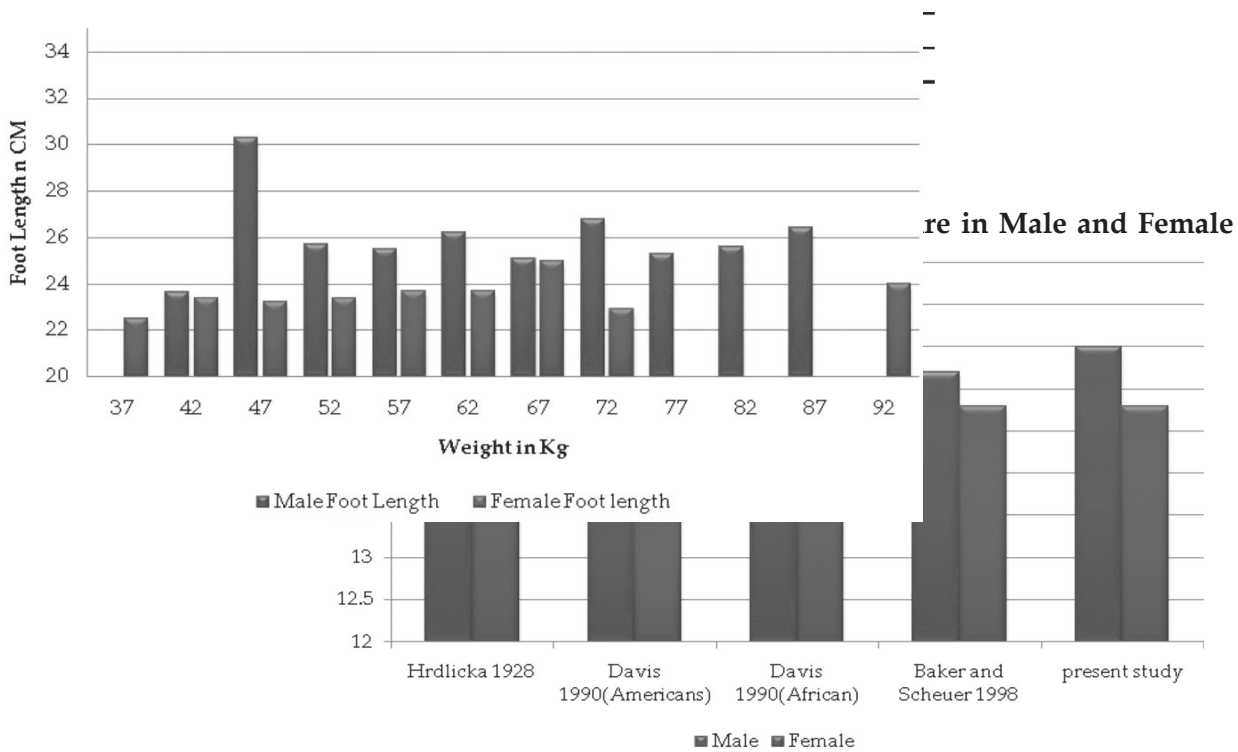
82 females, total 150 students. The data obtained for height and average foot length was divided into small groups of height for comparison as shown in the Table 1.

The data in table 1 is plotted graphically as seen in Graph 1.

From above graph it was noted that both in

**Graph 2: Comparison of Male and Female Foot Length with Weight**

**Table 3: Showing Correlation Coefficient(r) and Regression Equation in Different Studies**



males and females, as height increases average foot length also goes on increasing. It was also observed that for any given height, average foot length of male was always larger than

average foot length of female.

Foot length as a proportion of stature for men and women was also calculated. It was

15.2 in males and 14.8 in females.

The data obtained for weight and average foot length was also divided into small groups of weight as shown in the Table 2.

The data in table 2 is plotted graphically as seen in Graph 2.

From above graph it was observed that, there was no increase in foot length with increase in weight. So there was no any correlation between weight and foot length. But it was observed that for any given weight, average foot length of male was always greater than average foot length of female.

## Discussion

Various studies had done earlier on comparison of foot length in male and female. Ross and Ward (1982)[1], Robbins (1986)[2], Giles and Vallandigham (1991)[3], Barker and Scheuer (1998)[4], Wunderlich and Cavanagh (2001)[5] all documented that male foot length was proportionately larger than female foot length for given height. The findings of present study correlate with all above studies.

Foot length as a proportion of stature for men and women was 15.2 in males and 14.8 in females. This proportion was compared with previous study as shown in graph 3. It is observed that findings of present study correlates with findings of with Baker and Scheuer<sup>4</sup>. The proportion cited by Hrdlicka[6] was on higher side. Daniel M. T *et al*[7], in their study, quoted findings of Davis and Baker. According to Davis and Baker, foot length as a proportion of stature for men and women in American population was 14.3 and 13.5 and in African population was 15.4 and 15.2. Findings of present study were correlating with findings of African population.

Correlation coefficient (r) was calculated from entire data. It was 0.691 (p=0.00) for males and 0.694 (p=0.00) for females. So it means that there is strong positive correlation between height and foot length in males and females. These findings are also correlating

with previous studies.

The regression equation for height and foot length was calculated. It was  $Y=71.095+3.834X$  in males and  $Y=62.054+4.112X$  in females, where Y is the height and X is the mean foot length. Comparison of correlation coefficient and regression equation drawn in different studies was compared with Mansur DI *et al*[8], Dr. Sonali Khanapurkar *et al*[9], Patel S.M. *et al*[10], Jakhar J.K. *et al*[11] seen in Table 3.

Correlation between weight and foot length was not observed in present study, but average foot length of male was always greater than average foot length of female for given weight group.

## Conclusion

1. Male foot length is proportionately larger than female foot length for given height.
2. There was statically significant correlation between height and foot length in males and females.
3. The regression equation for height and foot length was  $Y=71.095+3.834x$  in males and  $Y=62.054+4.112x$  in females, where Y is the height and x is the mean foot length.

## References

1. Ross WD, Ward R. Human proportionality and sexual dimorphism. In: Hall RL, editor, Sexual dimorphism in Homo sapiens: A question of size. New York: Praeger; 1982, 317-361.
2. Robbins LM. Estimating height and weight from size of footprints. *J Forensic Sci.* 1986; 31: 143-152.
3. Giles E, Vallandigham PH. Height estimation from foot and shoeprint length. *J Forensic Sci.* 1991; 36: 1134-1151.
4. Barker SL, Scheuer JL. Predictive value of human footprints in a forensic context. *Med Sci Law.* 1998; 38: 341-346.
5. Wunderlich RE, Cavanagh PR. Gender

- differences in adult foot shape: Implications for shoe design. *Med Sci Sports Exerc.* 2001; 33: 605-611.
6. Hrdlicka A. The full-blood American negro. *Am J Phys Anthropol.* 1928; 12: 15-33.
  7. Daniel MT *et al.* Sexual dimorphism in foot length proportionate to stature. *Annals of Human Biology.* 2005; 32(1): 44-59
  8. Mansur DI, Haque MK, Sharma K, Karki RK, Khanal K, Karna R. Estimation of Stature from Foot Length in Adult Nepalese Population and its Clinical Relevance. *Kathmandu Univ Med J.* 2012; 37(1): 16-9.
  9. Khanapurkar S *et al.* Estimation of stature from the measurement of foot length, hand length and head length in Maharashtra region. *Indian Journal of Basic & Applied Medical Research.* 2012; 1(2): 77-85.
  10. Patel SM *et al.* Estimation of height from measurement of foot length in Gujarat region. *J Anat Soc India.* 2007; 56(1): 25-27.
  11. Jakhar JK *et al.* Estimation of Height from Measurements of Foot Length in Haryana Region. *J Indian Acad Forensic Med.* 32(3).
-