

# Forensic Estimation of Stature from Foot Length: An Autopsy based Study

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## Abstract

The present study was conducted on 224 dead bodies of Keralites (167 males and 57 females) aged between 20 and 60 years. The correlation coefficient calculated in males for the stature and right foot length (0.779) and left foot length (0.778); and the right foot length (0.653) and left foot length (0.638) in females were significant at 0.01 level. Males had significantly higher mean values for both stature and foot length compared to females. Regression equations were derived from right and left foot length for estimating stature in males and females. Stature (Y) could be calculated from the right foot length (X<sub>1</sub>) in males with the equation  $Y = 53.050 + 4.802 X_1$ . For the left foot length (X<sub>2</sub>) in males, the equation was  $Y = 53.618 + 4.7762 X_2$ . In females, the equations were  $Y = 78.538 + 3.597 X_1$  &  $Y = 78.724 + 3.601 X_2$  respectively.

**Key Words:** Foot Length, Forensic Stature Estimation, Human Identification, Physical Anthropology

## Introduction

Establishing the identity of a person is a major concern in Forensic medicine and Forensic Anthropology. Identity means the determination of individuality of a person<sup>1</sup>. The primary characteristics of identity are those of sex, age and stature and they may at once serve to disprove a supposed identity. Recovering of unknown bodies either in full or in part, as remnants or fragments or bodies in charred or putrefied state is a day to day affair in medico-legal practice.

Stature of an individual is an inherent characteristic, the estimate of which is considered to be an important assessment in the identification of unknown human remains. Most of the body parts bear a more or less constant relationship with stature.

## Materials and Methods

The study was conducted on 224 dead bodies of Keralities aged between 20 and 60 years brought for autopsy in the Department of Forensic Medicine at

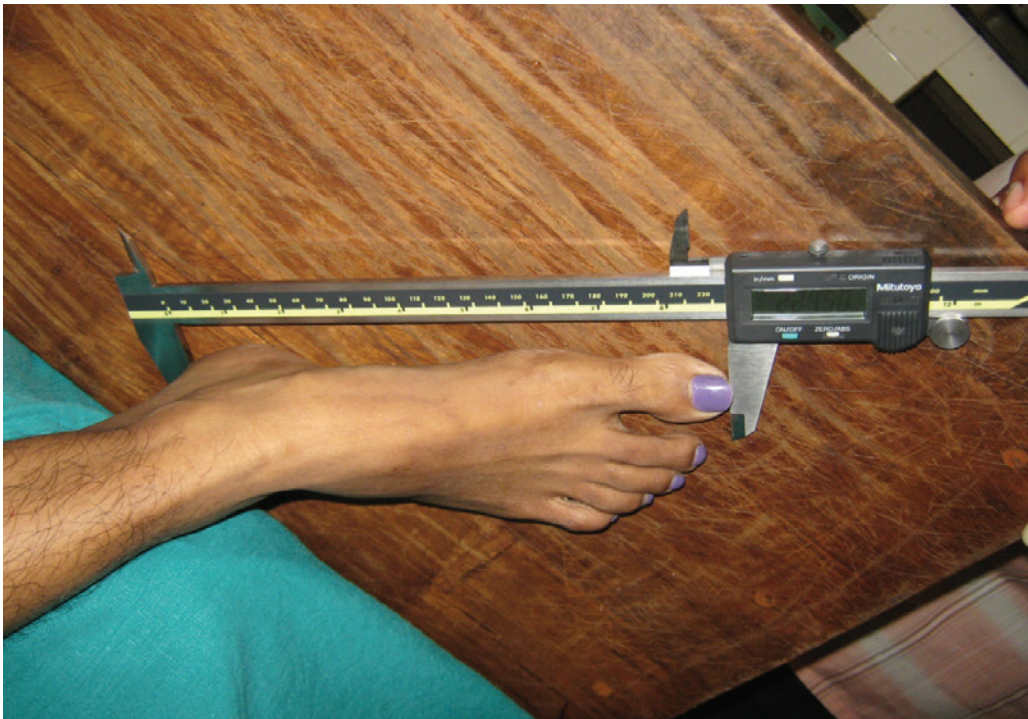
Medical College, Thiruvananthapuram, Kerala, India. Of these, 167 were males and 57 were females. The period of study was from November 2010 to November 2011. Dead bodies having any significant congenital or acquired deformities including fractures of spinal column or long bones and segmented, charred, mutilated or decomposed bodies were excluded. Past history of the cases were recorded in detail to rule out nutritional deficiency, abnormal growth pattern and hormonal imbalance. Whenever such abnormalities were noted, those cases were omitted from the study. The inquest reports were scrutinised and relevant data were recorded in the Proforma.

## Instruments Used for Measurement

A two meter long steel scale fixed to a straight wooden pole was used to measure stature in centimetres.

A Mitutoyo Digital Sliding Calliper (made in Japan) having an accuracy of 0.01 mm was used for measuring foot length. During the measurement, a wooden board

was used to keep the foot straight and perpendicular and a rectangular wooden block was used at the head end for measuring stature. (Fig 1)



**Fig 1: Measuring foot length using digital sliding calliper.**

### Statistical Analysis

The collected data were analysed using multiple regression analysis to derive formulae to estimate stature from foot length. As part of regression analysis, Pearson's product moment coefficient of correlation ( $r$ ), Analysis of Variance (ANOVA) and Multiple Correlation Analysis ( $R$ ) were done. In addition, paired sample 't' test and independent sample t-test (student t-test) was also applied in order to find out whether there is any significant difference between right and left foot length. Data were analysed separately for males and females.

### Results

The data collected was statistically analysed and the results of the study were tabulated and are given in Table 1.

**Table 1: Range, mean, standard deviation and correlation coefficient ( $r$ ) values of anthropometric measurements in adult males and females.**

Sl.No.	Gender	Parameters	Range (cm)	Mean	Standard Deviation	Correlation Coefficient
1.	Males	Stature	149-185	165.71	7.68	
2.		Right foot length	19.87-26.70	23.46	1.25	0.779*
3.		Left foot length	20.15-27.05	23.48	1.25	0.778*
4.	Females	Stature	145-175	155.39	5.71	
5.		Right foot length	19.32-23.44	21.36	1.04	0.653*
6.		Left foot length	19.02-23.36	21.29	1.01	0.638*

\*Significant at 0.01 level

There was significant positive correlation between stature and the foot length at the 0.01 level in males and females.

### Regression Equations

The regression equations derived for the present study are given in Table 2:

**Table 2: Regression equations derived**

	Gender	Regression model highly significant at the F value	The regression equation obtained
From rt. foot length	Male	F = 254.62; p < 0.01	Y* = 53.050 + 4.802 X1**
From lt. foot length		F = 252.48; p < 0.01	Y = 53.618 + 4.7762 X2***
From rt. foot length	Female	F = 40.81; p < 0.01	Y = 78.538 + 3.597 X1
From lt. foot length		F = 37.71; p < 0.01	Y = 78.724 + 3.601 X2

\*Y = Stature \*\*X<sub>1</sub> = Right foot length \*\*\*X<sub>2</sub> = Left foot length

### Discussion

From the above findings, the feet were observed to be longer in males compared to females. This finding is in agreement with the findings of Giles and Vallandigham (1991), who used measurements obtained from young adult male and female recruits in the US army<sup>2</sup>; Baker and Scheuer (1998) who studied UK residents<sup>3</sup>; Ashizawa et al. (1997) who studied Javanese, Filipinas and Japanese<sup>4</sup>; Ilayperuma et al. (2009) who studied Sri Lankans<sup>5</sup> and Rani et al. (2011) who studied Indian subjects<sup>6</sup>.

Prior studies as those done by Philip (1990), who studied Indian subjects<sup>7</sup>; Sanli et al. (2005) who conducted a study on Turkish subjects<sup>8</sup>; Patel et al. (2007) who studied the inhabitants of Gujarat region in India<sup>9</sup>; Ilayperumana et al. (2009)<sup>5</sup>; Chavan et al. (2009) who studied the inhabitants of Maharashtra region<sup>10</sup> and Rani et al. (2011)<sup>6</sup> had showed a high positive correlation between stature and foot length. The present study showed results in line with the published data.

The present study derived regression equations for estimating stature from right and left foot length which

can be applied for forensic stature estimation to help law enforcement. Further study on the same population is recommended to validate the findings of the study.

**Ethical Concerns:** Human Ethics Committee, Medical College, Thiruvananthapuram, through Institutional Ethics Committee (IEC) and Institutional Review Board (IRB) approved the study on 12/11/2010. The data was collected during routine medico-legal autopsy examination and no information which could reveal the identity of the deceased are published.

**Conflict of Interest Statement:** The authors declare no conflict of interest. The research was self funded.

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