CHAPTER I

INTRODUCTION

Footprints are of immense value in establishing personal identity of the criminals in forensic examinations. They are found as a kind evidence at the crime site and link between the crime and the perpetrator. Although, footprints can be collected from almost all types of crime scenes but the possibility of their recovery at the scenes of sexual offences and homicides is relatively more. Examination of barefoot impressions is important especially in developing countries like India where majority of the rural population like to walk barefooted because of socio-economic and climatic reasons. The partial or complete footprints can be found on rain covered surfaces, newly waxed floors, freshly cemented surfaces, moistened surfaces, in dust, mud, sand, oil, paint and can be left in blood at the murderer scene. [5]

Analysis of footprints helps in estimation of an individual's stature because of existence of strong positive correlation between one's stature and foot size; the footprints are also considered as indicators of skeletal and body structure of a person. Gayer was probably the first person to conduct a detailed study of footprints while working in the United Province of India and published his results in the form of a book. Earlier studies by Robbins, Barker and Scheuer, Topinard, Martin, Martin and Saller, Pales, Jasuja, provide a number of foot length/stature percentages for various populations ranging from 14.9 to 18.1. Some studies have derived multiplication factors calculated by dividing stature by a foot/footprint measurements. [2]

Height is also important, because it is closely correlated with other health components, such as life expectancy. Individuals of small stature are also

more likely to have lower blood pressure and are less likely to acquire cancer.

Foot print is a common and important mark in the crime scene. It helps to important conclusions about individuals who were press that arena during the crime. Foot prints are typically used by the prosecution to help prove an individual committed a crime, or was at least present at the scene of a crime, and thus could have committed it.[3]

Foot prints can also allow the detective to find the approximate height from, foot print and shoe print. The foot tends to be approximately 15% of the person's average height. Individualistic characteristics of the footprints like numerous creases, flatfoot character, horizontal and vertical ridges, corns, deformities etc. can help the forensic scientist in cases pertaining to criminal identification. In some forensic cases, the need may also arise to estimate body weight from the size of the footprints.[5]

Stature or standing height is one of the most important elements in the identification of an individual. It is the most offend used anthropometric dimension. Estimation of individuals stature is an important parameter in forensic examinations. It is defined as the vertical distance between the higest point of vertex and the heal touching the floor. Examination of foot prints provides important evidence in a crime scene investigation and helps in estimation of stature of a criminal. Analysis of bare foot prints is often carried out in developing countries like India where the foot prints are frequently recovered at the scene of crime.[3]

There have been several studies conducted on different population groups in different parts of world to estimate stature from different parts of body. Several workers have shown a significant correlation between foot meas-

rements and stature in different castes and tribes of different parts of countries. The present study was carried out to investigate the relationship between foot dimension and stature among group of male in the population of Kerala.[4]

Footprints are the impressions or images left behind by a person walking or running. Hoofprints and pawprints are those left by animals with hooves or paws rather than feet, while shoeprints is the specific term for prints made by shoes. They may either be indentations in the ground or something placed on to the surface that was stuck to the bottom of the foot. A trackway is set of footprints in soft earth left by a life-form; animal tracks are the footprint, hoofprints, or pawprints of an animal.[7]

The imagery of footprints has been used in many areas of popular culture. Several poems and songs have been written about them, with the Christian poem, foot prints being one of the best known. Prints or impressions of a child's feet can be kept as a memento by parents. Usually this is done using paint. The impressions of celebrity's feet, usually in concrete, may be kept in a collection such as that outside Grauman's Chinese Theatre.[9]

CHAPTER 2
LITERATURE REVIEW

Giles. E et.al (1990) studied "Height Estimation from Foot and Shoeprint Length" in that study it explains foot length displays a biological correlation with height that suggests the latter might be estimated from foot- or shoeprints when such evidence provides an investigator the best or only opportunity to gauge that aspect of a suspect's physical description. Previous utilization of percentages and linear regressions of foot length to make height estimates is reviewed and appraised, as is such use of shoeprints. Newly determined percentages and linear regressions for determining height from foot length for young adult males and females based upon very large U.S. Army anthropometric databases are presented and evaluated. Suggestions are made for the practical employment of shoeprint length, preferably as a direct measurement but also indirectly as a shoe size indicator, for height assessment.

Kewal Krishan (2008) "Estimation of stature from footprint and foot outline dimensions in Gujjars of North India", in this study it explains that Estimation of individual's stature is an important parameter in forensic examinations. Examination of footprints provides important evidence in a crime scene investigation and helps in estimation of stature of a criminal. Analysis of bare footprints is often carried out in developing countries like India where the footprints are frequently recovered at the scene of crime. The present study attempts to reconstruct stature in a sample of 2080 bilateral footprints and foot outlines collected from 1040 adult male Gujjars of North India ranging in age from 18 to 30 years. Bilateral footprints and foot outlines of each individual were measured for ten and eight measurements, respectively. The results indicate that T-2 length (length of the footprint from heel to 2nd toe) and T-5

length in footprint and T-1 length, T-4 length and breadth at ball in foot outline show statistically significant bilateral asymmetry. Significant and positive correlation coefficients exist between stature and various measurements of footprint and foot outline ($P < 0.001$ and 0.01) except toe 1–5 angle of declination which shows insignificant correlation coefficient. The highest correlation coefficients were shown by the toe length measurements (0.82–0.87) indicating a close relationship between the stature and these measurements. Regression analysis presents smaller mean errors (2.12–3.92 cm) in estimation of stature than those of division factor method (3.29–4.66 cm), thus, gives better reliability of esti mate than the latter. The regression equations were also checked for their accuracy by comparing the actual stature with estimated stature.

Ramneet Kaur et.al (2008) "Stature estimation from foot dimensions", in this study it explains that the identification of an individual is the mainstay in forensic investigations. The dimensions of the foot have been used for the determination of sex, age, and stature of an individual. The present study examines the relationship between stature and foot dimensions among Gujjars, a North Indian endogamous group. Stature, foot length and foot breadth of 200 subjects comprising 100 males and 100 females were measured. Statistical analyses indicated that the bilateral variation was insignificant for all the measurements except foot breadth in males ($p < 0.01$). Sex differences were found to be highly significant for all the measurements ($p < 0.01$). Linear and multiple regression equations for stature estimation were calculated using the aforementioned variables and multiplication factors were computed. The correlation coefficients between stature and foot dimensions were found to be positive and statistically highly significant. The highest correlation coefficient between stature and foot length in males and foot breadth in females indicates that the foot length provides the highest reliability and accuracy in estimating

stature of an unknown male and foot breadth in a female. Prediction of stature was found to be most accurate by multiple regression analysis.

Irene Atef Fawzy (2010) "Stature and Body Weight Estimation from Various Footprint Measurements Among Egyptian Population", in this study it explains that Analysis of footprints can reveal very important clues which can be used as a forensic evidence and help in the estimation of stature and body weight of an individual. In this work, bilateral footprints were obtained from 50 male Egyptian medical students ranging in age between 18 and 25. Nine measurements were taken on each footprint. The result revealed significant bilateral asymmetry ($p<$ 0.001) except foot breadth at ball. The significant and positive highest correlation coefficients with stature were shown by toe-5 length on right side ($R=$ 0.58) and with body weight by foot breadth at ball on left side ($R-0.52$). Regression equations presented smaller standard errors of estimate (3.52–4.69) in determination of stature than those in estimation of body weight (4.05–5.28). In conclusion, this study has provided equations that help to estimate stature and body weight from footprint measurements among Egyptians.

Tanuj Kanchan (2010) "Stature Estimation from Foot Length Using Universal Regression Formula in a North Indian Population", in this study it explains that the stature is a significant parameter in establishing identity of an unknown. Conventionally, researchers derive regression formula separately for males and females. Sex, however, may not always be determined accurately, particularly in dismembered remains and thus the need for a universal regression formula for stature estimation irrespective of sex of an individual. The study was carried out in an endogamous group of North India to compare the accuracy of sex-specific regression models for stature estimation from foot

length with the models derived when the sex was presumed as unknown. The study reveals that regression equation derived for the latter can estimate stature with reasonable accuracy. Thus, stature can be estimated accurately from foot length by regression analysis even when sex remains unknown.

Rom J. Leg Med et.al (2012) "Predictive role of hand and foot dimensions in stature estimation", in this study it explains that the stature estimation is a commonly used parameter in identification searched by medico-legal experts and forensic anthropologists. To estimate stature; measurements of hand length (HL), hand breadth (HB), wrist breath (WB), foot length (FL), foot breadth (FB) and ankle breadth (AB) were used in this study. It was aimed to predict most useful variables and to perform formulas originated from those variables significantly correlated to stature. Measurements were obtained from 356 volunteers. The best correlation value among searched variables were detected in foot dimensions as FL variable for males r=0.696 and for females r=0.496 and in hand dimensions as HL variable for males r=0.578 and for females r=0.309, respectively. The least estimation error in stature prediction was achieved with using all variables in defined regression equations. Lengths measurements be long to hand and foot dimensions were more useful parameters than breadth measurements of those in stature estimation.

Sarah Reel et.al (2012) studied "Estimation of stature from static and dynamic footprints", in this study it explains the ability to estimate accurately from known parameters is a fundamental aspect of science and is evident as an emerging approach in the area of footprints and stature estimation within the field of forensic identification. There are numerous foot dimensions that have been measured in the literature to predict stature with varying degrees of confidence but few studies have tried to link the strength of estimation to anatomical landmarks. Such an approach is utilised in this study which estimates stature

from the right footprints of sixty one adult male and female UK participants. Static and dynamic footprints were taken from each volunteer using the 'inkless paper system'. The prints were digitised and twelve length, width and angle measurements were chosen for the analysis. The highest correlations with stature were shown to be the heel to fourth toe print for the static group of footprints ($r = 0.786$, $p < 0.01$), and the heel to fifth toe print in the dynamic footprints ($r = 0.858$, $p < 0.01$). Collinearity statistics suggest the heel to fifth toe print length measurement is independent and not influenced by any other variables in the estimation of stature for the dynamic prints. Linear regression equations for this measurement presented the smallest standard error of estimate (SEE) and highest shared variance (R^2) of all included variables (SEE 4.16, R^2 0.74). Our study discusses a potential anatomical explanation as to why the lateral border of the foot and hence the impression it makes upon a hard surface, is a more stable indicator in the estimation of stature. The investigation recommends the use of Calc_A4 and Calc_A5 length measurements when estimating stature from footprint impressions.Tanuj Kanchan (2013) Foot length is a functional parameter for assessment of height in which it explains Stature estimation is considered as an important parameter in the examination of unknown human remains and during the analysis of evidence in crime scene investigations. During mass disasters isolated foot can be found enclosed in the shoes while footprints may be recovered at the crime scenes. Foot length and footprint length can provide valuable estimates of stature. The present communication makes a few pertinent observations on a recently published article in 'The Foot' entitled 'Foot length—a functional parameter for assessment of height, The Foot 2012, 22(1):31–34' and presents an insight into the literature available on the subject which is likely to be of value to future researchers in the field of Forensic podiatry. The foot length and the footprint length of individuals differ from

each other and hence, the research observations made in a study on foot prints cannot be applied to foot dimensions.

Daniel Franklin (2013) “Estimation of stature using anthropometry of feet and footprints in a Western Australian population”, in this study it explains that the aim of the study is to develop accurate stature estimation models for a contemporary Western Australian population from measurements of the feet and footprints. The sample comprises 200 adults (90 males, 110 females). A stature measurement, three linear measurements from each foot and bilateral footprints were collected from each subject. Seven linear measurements were then extracted from each print. Prior to data collection, a precision test was conducted to determine the repeatability of measurement acquisition. The primary data were then analysed using a range of parametric statistical tests. Results show that all foot and footprint measurements were significantly ($P < 0.01$–0.001) correlated with stature and estimation models were formulated with a prediction accuracy of ±4.673 cm to ±6.926 cm. Left foot length was the most accurate single variable in the simple linear regressions (males: ±5.065 cm; females: ±4.777 cm). This study provides viable alternatives for estimating stature in a Western Australian population that are equivalent to established standards developed from foot bones.

T. Nataraja Moorthy (2014) “Stature estimation from footprint measurements in Indian Tamils by regression analysis”, in this study it explains stature estimation is of particular interest to forensic scientist for its importance in human identification. Footprint is one piece of valuable physical evidence encountered at crime scenes and its identification can facilitate narrowing down the suspects and establishing the identity of the criminals. Analysis of footprints helps in estimation of an individual’s stature because of the existence

of the strong correlation between footprint and height. Foot impressions are still found at crime scenes, since offenders often tend to remove their footwear either to avoid noise or to gain a better grip in climbing walls, etc., while entering or exiting. In Asian countries like India, there are people who still have the habit of walking barefoot. The present study aims to estimate the stature in a sample of 2,040 bilateral footprints collected from 1,020 healthy adult male Indian Tamils, an ethnic group in Tamilnadu State, India, who consented to participate in the study and who range in age from 19 to 42 years old; this study will help to generate population-specific equations using a simple linear regression statistical method. All footprint lengths exhibit a statistically positive significant correlation with stature (p-value < 0.01) and the correlation coefficient (r) ranges from 0.546 to 0.578. The accuracy of the regression equations was verified by comparing the estimated stature with the actual stature. Regression equations derived in this research can be used to estimate stature from the complete or even partial footprints among Indian Tamils.

Petra Uhrova (2015) et.al "Estimation of stature using hand and foot dimensions in Slovak adults" in this study it explains that the hand and foot dimensions used for stature estimation help to formulate a biological profile in the process of personal identification. Morphological variability of hands and feet shows the importance of generating population-specific equations to estimate stature. The stature, hand length, hand breadth, foot length and foot breadth of 250 young Slovak males and females, aged 18–24 years, were measured according to standard anthropometric procedures. The data were statistically analyzed using independent t-test for sex and bilateral differences. Pearson correlation coefficient was used for assessing relationship between stature and hand/foot parameters, and subsequently linear regression analysis was used to estimate stature. The results revealed significant sex differences in hand and foot dimensions as well as in stature ($p < 0.05$). There was a positive

and statistically significant correlation between stature and all measurements in both sexes ($p < 0.01$). The highest correlation coefficient was found for foot length in males ($r = 0.71$) as well as in females ($r = 0.63$). Regression equations were computed separately for each sex. The accuracy of stature prediction ranged from ±4.6 to ±6.1 cm. The results of this study indicate that hand and foot dimension can be used to estimate stature for Slovak for the purpose of forensic field. The regression equations can be of use for stature estimation particularly in cases of dismembered bodies.

CHAPTER 3

AIM AND OBJECTIVES

AIM :

To predict the height of an individual from footprint.

OBJECTIVES:

- To identify the variation of height by comparing the predicted height with actual height.
- To establish the personal identification by using the height.

CHAPTER 4

MATERIALS AND METHODOLOGY

MATERIALS REQUIRED

- Footprint Sample of right leg
- Scale
- Pencil
- Paper
- Ink
- Ink pad
- Roller

METHODOLOGY

Footprints were obtained from 100 male and 100 female participants. The study subjects comprised of participants who were 18-26 years old college-going students of Kerala population. Only those students with healthy and normal feet were included in this study. The ink was uniformly spread on a glass slab using a roller and the subject was first asked to place their feet on the slab and then on a plain white sheet of paper. The footprints thus obtained were filed. The footprints obtained from the right foot of the subjects were selected for the study (the 0.95-0.99 length correlation between the right and the left footprints, as stated by Robbins makes it apparent that either foot can be used for estimating stature). Maximum foot print length was measured as a straight distance between the highest points on the first or the second toe (whichever was higher) and the lowest

point on the margin of the heel. Stature of each individual was measured as a vertical distance from the floor to the vertex. The subject was asked to stand bare foot and with the head in the Frankfurt plane. The data collected was then analyzed using linear regression equations which were derived to determine the stature from maximum foot print length. The results obtained were compared with the actual stature of the subjects.

CHAPTER 5

OBSERVATIONS AND CALCULATIONS

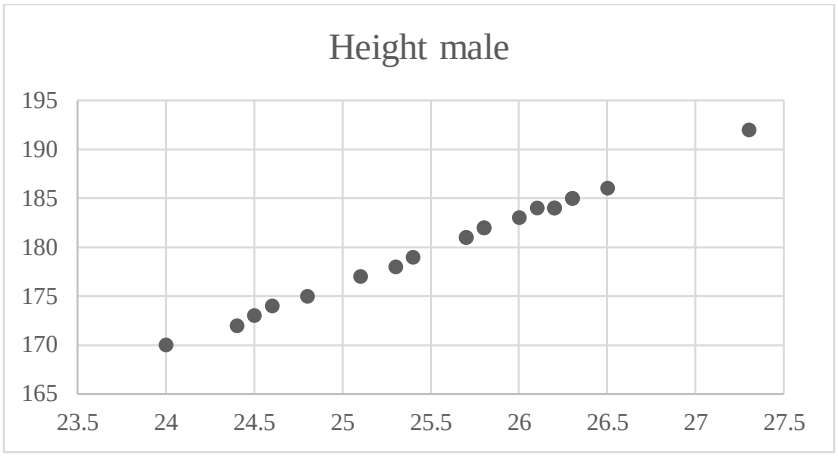
Table:-1 The table shows the database of 20 male subjects

Samples	**Age**	**Gender**	**Maximum Foot-print Length (x)**	**Predicted Height (Y)**	**Actual Height**
Sample 1	18	M	25.7	181.0151446	181
Sample 2	18	M	24	169.7076865	170
Sample 3	18	M	24.6	173.698554	174
Sample 4	18	M	25.4	179.0197108	179
Sample 5	18	M	24.8	175.0288432	175
Sample 6	19	M	24.5	173.0334094	173
Sample 7	19	M	25.1	177.024277	177
Sample 8	19	M	25.3	178.3545662	178
Sample 9	19	M	26.2	184.3408676	184
Sample 10	19	M	24.4	172.3682648	172
Sample 11	20	M	26.3	185.0060122	185
Sample 12	20	M	25.7	181.0151446	181
Sample 13	20	M	26.2	184.3408676	184
Sample 14	20	M	25.8	181.6802892	182
Sample 15	20	M	27.3	191.6574581	192
Sample 16	21	M	26.3	185.0060122	185
Sample 17	21	M	26	183.0105784	183
Sample 18	21	M	25.8	181.6802892	182
Sample 19	21	M	26.5	186.3363014	186
Sample 20	21	M	26.1	183.675723	184

Table :-2 The table shows the database of 20 female subjects

Samples	**Age**	**Gender**	**Maximum Foot-print Length**	**Predicted Height**	**Actual Height**
Sample 21	18	F	21.6	152.2283255	154
Sample 22	18	F	22.1	156.0737527	157
Sample 23	18	F	22.8	161.4573508	162
Sample 24	18	F	21.9	154.5355818	156
Sample 25	18	F	22.2	156.8428381	158
Sample 26	19	F	21.5	151.4592401	153
Sample 27	19	F	22.4	158.381009	159
Sample 28	19	F	22.3	157.6119236	158
Sample 29	19	F	21.8	153.7664964	145
Sample 30	19	F	23.6	167.6100343	167
Sample 31	20	F	22.6	159.9191799	160
Sample 32	20	F	22.8	161.4573508	162
Sample 33	20	F	23.3	165.302778	165
Sample 34	20	F	22.7	160.6882653	161
Sample 35	20	F	23.1	163.7646071	164
Sample 36	21	F	23.2	164.5336925	164
Sample 37	21	F	22.5	159.1500945	160
Sample 38	21	F	22.3	157.6119236	158
Sample 39	21	F	23.2	164.5336925	164
Sample 40	21	F	23.4	166.0718634	166

Graph 1: The graph plotted between the maximum footprint length and height for the male study population.



Graph 2: The graph plotted between the maximum footprint length and height for the male study population.

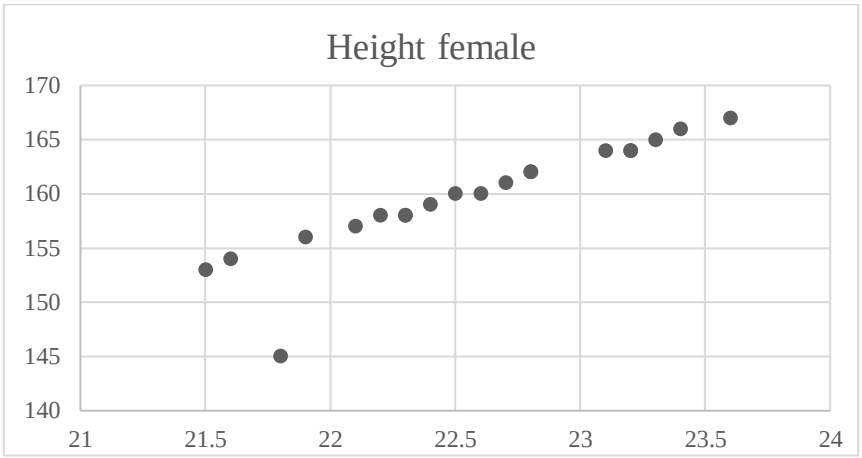


Table 3: The table shows the regression statistics for male

Regression Statistics	
Multiple R	0.99895781
R Square	0.997916707
Adjusted R Square	0.997800968
Standard Error	0.259660304
Observations	20

Table 4: The table shows the regression statistics for female

Regression Statistics	
Multiple R	0.908077221
R Square	0.824604239
Adjusted R Square	0.81486003
Standard Error	2.234814153
Observations	20

Table 5: The table shows the regression equation coefficients for male.

Measurements	**Coefficients**
Intercept	10.07298326
Footprint Length Female	6.651445967

Table 6: The table shows the regression equation coefficients for female.

Measurements	**Coefficients**
Intercept	-13.89412917
Footprint Length Female	7.690854384

Table 7: The table shows the regression equation for predicting the height of both males and females.

Gender	**Regression Equation**	**Standard Error**
Male	Y=6.65x + 10.07	0.259660304
Female	Y= 7.69x -13.89	2.234814153

x = foot print length, Y = height

CALCULATIONS

The application of the formula in the collected data can be done by taking the examples of any of the male and female subject.

The sample1 taken from male, then the calculations will be;

Y= 6.651445967x + 10.07298326

Y= 6.651445967 (25.7) + 10.07298326

Y= 181.0151446

The sample 21 taken from female, then the calculations will be;

Y= 7.690854384 x - 13.89412917

Y= 7.690854384 (21.6) - 13.89412917

Y= 152.2283255

CHAPTER 6
RESULT AND CONCLUSION

RESULT

The study shows the correlation between the two variables i.e footprint length and the actual height of the person. One of the variable should be independant and the other should be dependant on the independent variable. Here, height is the independent variable and footprint length is the dependant variable. The study is conducted based on the regression analysis of both male and female subjects separately. The height of a person can be successfully predicted approximately by using this method. However, the precise prediction of height from an individual's footprint may be an unachievable and unnecessary goal, there would always be an estimation error of a few centimeters occur. For males . 0.259660304 is the standard error. For females 2.234814153 is the standard error. But can estimate an approximate value of height.

CONCLUSION

From the present study, the study has revealed a highly significant degree of correlation between the measurements of footprint lengths and stature from footprints of 20 subjects of both sexes between the ages of 18-21 years. Regression formulae have been developed to predict stature separately for males and females data along with the standard error of estimate. The results obtained are found to show less error in predicting stature as compared to other conventional methods used earlier. In the present study samples were taken only from the right foot of the individual so this study is not reliable. Because there will be the variation in the measurements if the samples taken from both the foot.

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