Quest Journals
Journal of Education, Arts, Law and Multidisplinary
Volume 15 ~ Issue 5 (Sep. – Oct. 2025) pp: 42-49
ISSN(Online): 2347-2895
www.questjournals.org

Research Paper

Correlation Between Stature and Footprint Dimensions

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ABSTRACT
Estimation of individual's stature is an important parameter in forensic examinations. Examination of footprint provides important evidence in a crime scene investigation and it helps to narrow down the investigation process. The present study aims to analyze the correlation between the stature and footprint dimensions. For this study the sample would be collected from student population in the age group of 15-25 years old and it ranging from 50 males & 50 females. The datas were analyzed by using excel. The Pearson correlation analysis was used to estimate the correlation between stature and footprint dimension. According to this study, the correlation between the stature and measured footprints parameters shows the significant level of correlation. The present study proves that male have larger foot dimensions then females and males have the most significant level of correlation between the stature and the footprint dimensions compare with females. The current study shows the most significant correlation between stature and footprint dimension through this we can able to estimate stature from foot dimension.

Key words
Footprint dimension, Identification, Pearson correlation, Stature

***R**eceived 13 Sep., 2025; **R**evised 25 Sep., 2025; **A**ccepted 28 Sep., 2025* *© The author(s) 2025.*
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I. INTRODUCTION

A footprint is an impact or Mark left by a foot at the surface. It may be a naked footprint, a shoeprint, or maybe a hint left through an item like a boot. These footprints may be used as proof in forensic investigations to assist decide the presence of people at the scene, their gait patterns, and probably even their sex and weight. Footprints are found on diverse crime scenes, consisting of soil, snow, mud, and different smooth surfaces. Comparing those traits can assist you pick out suspects or victims. Footprints can also offer oblique statistics approximately a person's gait, height, weight, or even any accidents or disabilities which can have an effect on their walking.

Footprints are preserved through numerous methods, together with images and casting, to make sure their integrity is for evaluation.

1.1 Types of Footprints

Footprint evidence, like fingerprints, may be categorized into three types: latent, patent, and plastic. Latent footprints are invisible to the bare eye and require processing to end up seen, frequently the usage of dusting or chemical techniques. Patent footprints are seen without processing, frequently created whilst dirt, blood, or different substances switch a footprint to a surface. Plastic footprints are 3-dimensional impressions left in smooth substances like mud, sand, or snow.

1.1.2 Latent Footprints

These are invisible to the bare eye and are created whilst sweat, oil, or different residues from the only of a shoe switches to a surface.

1.1.3 Patent Footprints

These are seen prints which might be created whilst a substance like blood, dirt, or ink transfers a footprint to a surface.

1.1.4 Plastic Footprints

These are third-dimensional impressions left in smooth substances whilst a shoe or tire is pressed into the surface.

1.2 Methods for Collecting Footprint Evidence

Collecting footprint proof entails photographing the prints, doubtlessly improving seen or latent impressions, and developing casts of three-d impressions. For two-dimensional impressions on surfaces, lifting strategies can be used, even as for tender surfaces, casting is common.

- Photographing prints from a couple of angles below right light situations and the use of ABFO (American Board of Forensic Odontology) scales for size.
- Making casts - pouring dental stone, plaster, silicone or different substances into the print to seize intensity and contours.
- Protecting impressions through constructing shelters or windbreaks around them at outside scenes.
- Lifting prints using the use of adhesives, gelatin lifts, electrostatic strategies or chemical enhancers.
- Properly packaging, labeling and storing footprint impressions to keep away from harm at some point of shipping and storage.
- Through documentation guarantees investigators can maintain the authenticity of the evidence. (Hawkeye Forensic, 2024)

1.3 Pearson correlation coefficient

The Pearson correlation coefficient (r) is the maximum extensively used correlation coefficient and is understood with the aid of using many names:

- Pearson’s r
- Bivariate correlation
- Pearson product-second correlation coefficient (PPMCC)
- The correlation coefficient

The Pearson correlation coefficient is a descriptive statistic, which means that it summarizes the traits of a dataset. Specifically, it describes the power and route of linear dating among quantitative variables.

The Pearson correlation coefficient is an inferential statistic, which means that it is able to be used to check statistical hypotheses. Specifically, we will take a look at whether there may be great courting among variables.

The Pearson correlation coefficient (r) is one of numerous correlation coefficients which you want to select while you need to determine a correlation. The Pearson correlation coefficient is a superb desire whilst all the following are true:

- Both variables are quantitative: You will want to apply a unique approach if both of the variables are qualitative.
- The variables are commonly distributed: You can create a histogram of every variable to affirm whether the distributions are about normal. It’s now no longer a problem if the variables are a bit non-normal (Byers, S. N. (2016).

II. METHODOLOGY

2.1 AIM

The aim of the study is to analyze the correlation between the stature and footprint dimension.

2.2OBJECTIVE

- **To quantify the relationship** between key footprint dimensions and the stature of individuals.
- **To derive gender-specific linear regression equations** for predicting stature from measured footprint parameters.
- **To evaluate the predictive accuracy** of these regression models by comparing estimated heights against actual statures for both male and female participants.
- **To assess differences in correlation strength** between left vs. right footprints and between male vs. female subjects, in order to inform best practices for forensic application.

2.3 PROBLEM STATEMENT

- Research will be conducted to determine the stature of a person from footprint.
- The previous research was related to estimating stature by using long bones and foot dimensions, but very fewer studies were conducted using footprint measurements to estimate stature.

2.4 NEED AND SIGNIFICANCE OF THE STUDY

The estimated stature of the footprint is used to identify the unknown person, which helps to narrow down the investigation process. This study can be used in the field of forensic science to determine the stature of a person through footprints. This study aims to determine the correlation between the stature and footprint of 15–25 year-olds.

2.5 ETHICAL CONSIDERATION

- Informed consent from all participants.
- Confidentiality of information (height, footprint and other personal information)
- Voluntary participation.

2.6 MATERIALS AND METHODS

- Participant consent forms
- Footprint sample -collected using ink and paper
- Measuring tools-ruler, scale, pencil
- Statistical software -SPSS or Excel

2.7 RESERCH DESIGN

This study predominantly employed a quantitative research methodology.

2.8 SAMPLELING METHODS:

The research employed probability sampling in that I used convenient sampling techniques to select the participants. It specifically targets 15-25-years-old people.

2.9 SAMPLE SIZE

The stature and footprint were obtained from fifty males and fifty females, aged between 15–25 years old.

2.10 INCLUSION CRITERIA

The people selected for this study are, who are all between the ages of 15-25 years of both genders (male and female).

2.11 EXCLUSION CRITERIA

The subject excludes for this study, who are all who under the age of 15 years and above the age of 25 years old, people who all have foot deformities, injuries and scars in the foot region.

2.12 SAMPLE COLLECTION

After getting informed consent from all the participants, the data collection procedure started. The stature and foot impressions are collected from a selected population.

2.13: TOOLS AND TECHNIQUES

Footprints are collected using an ink pad and a clean sheet of paper. Foot prints are taken after applying ink on both the feet of the subjects and asking them to place their foot on a clean sheet of paper. The foot impressions are measured using a measuring scale. It contains seven measurements.

Footprint measurements taken for observation

1. Heel to Toe-1
2. Heel toToe-2
3. Heel to Toe-3
4. Heel to Toe -4
5. Heel to Toe-5
6. Breath of ball
7. Breath of heel

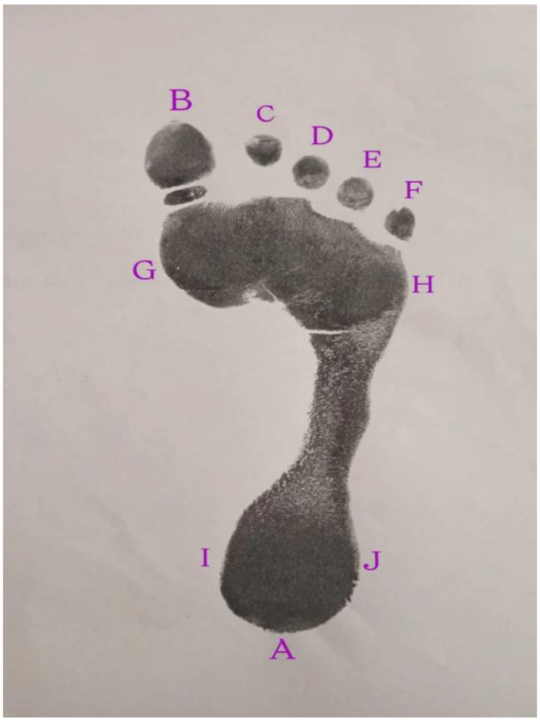


Image1: Parameters taken for sample analysiss

The stature is also measured for the same individual by using standard measuring tape. The stature of the person was measured from the horizontal floor to the vertex (highest point of the head) when the subject was standing in an erect posture

2.14: DATA ANALYSIS
The data was subjected to statistical analysis using Excel & SPSS. The data analysis included descriptive statistics, regression equations and person correlation.
2.15: LIMITATIONS

- Difficulties in obtaining samples from 15-25-years old people.
- Stature is measured by using measuring tape due to a lack of resources. So, the measured stature has little variation from the actual stature.
- Participants may have faced some difficulties while collecting the footprints using an ink pad and flat surface paper.
- The accuracy of footprint measurements may be questionable because the footprint dimensions are measured using a measuring scale.

III. OBJECTIVE AND RESULT

Table 1: correlation between stature and female left footprint.

S.NO:	PARAMETERS	NUMBER OF SAMPLE	PEASON CORELATION VALUE	T-VALUE	SIGNIFICANCE& P VALUE
1.	HEIGHT& TOE 1	50	0.684	6.498	0.000
2.	HEIGHT& TOE 2	50	0.683	6.480	0.001
3.	HEIGHT& TOE 3	50	0.703	6.857	0.000
4.	HEIGHT& TOE 4	50	0.657	6.040	0.004
5.	HEIGHT& TOE 5	50	0.684	6.505	0.002
6.	HEIGHT& BREATH OF BALL	50	0.515	4.165	0.001
7.	HEIGHT& BREATH OF HEEL	50	0.447	2.352	0

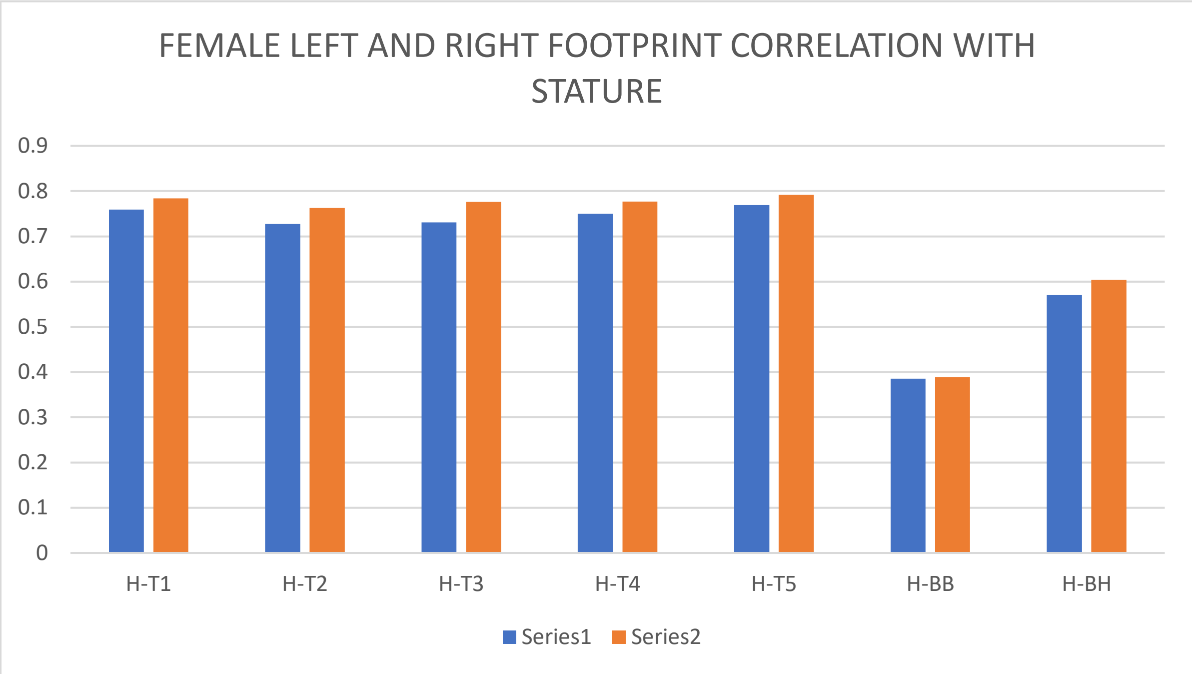
Correlation between the female stature and, heel to toe 1, heel to toe 2, heel to toe3, heel to toe 4, heel to toe 5, breath of ball, breath of heel left footprint shows a P value < 0.001 hence it is highly significant. Correlation between the female stature and left footprint shows a P value <0.005 hence it is significant. Correlation between the female stature and heel of left footprint shows a P value >0.005 hence it is not significant.

Table 2: correlation between stature and female right footprint.

S.NO:	PARAMETERS	NUMBER: OF SAMPLE	PEASON CORELATION VALUE	T-VALUE	SIGNIFICANCE& P VALUE
1.	HEIGHT& TOE 1	50	0.630	5.261	0.001
2.	HEIGHT& TOE 2	50	0.690	6.193	0.693
3.	HEIGHT& TOE 3	50	0.654	6.002	0.516
4.	HEIGHT& TOE 4	50	0.649	5.921	0.003
5.	HEIGHT& TOE 5	50	0.366	2.730	0.001
6.	HEIGHT& BREATH OF BALL	50	0.099	0.695	0.075
7.	HEIGHT& BREATH OF HEEL	50	0.246	1.705	0.095

Correlation between the female stature and heel to toe 1, heel to toe 4, heel to toe5, breath of ball, breath of heel of right footprint shows a P value <0.001 hence it is highly significant. Correlation between the female stature and right footprint shows a P value <0.005 hence it is significant. Correlation between the female stature and heel to toe2, heel to toe3 of right footprint shows a P value >0.005 hence it is not significant.

Graph 1: correlation between stature and female footprints.



3: correlation between stature and male right footprint.

S.NO:	PARAMETERS	NUMBER: OF SAMPLE	PEASON CORELATION VALUE	T-VALUE	SIGNIFICANCE& P VALUE
1.	HEIGHT& TOE 1	50	0.759	8.088	0.000
2.	HEIGHT& TOE 2	50	0.727	7.353	0.004
3.	HEIGHT& TOE 3	50	0.731	7.443	0.003
4.	HEIGHT& TOE 4	50	0.750	7.872	0.008
5.	HEIGHT& TOE 5	50	0.769	8.358	0.002
6.	HEIGHT& BREATH OF BALL	50	0.385	2.890	0.006
7.	HEIGHT& BREATH OF HEEL	50	0.570	4.809	0.000

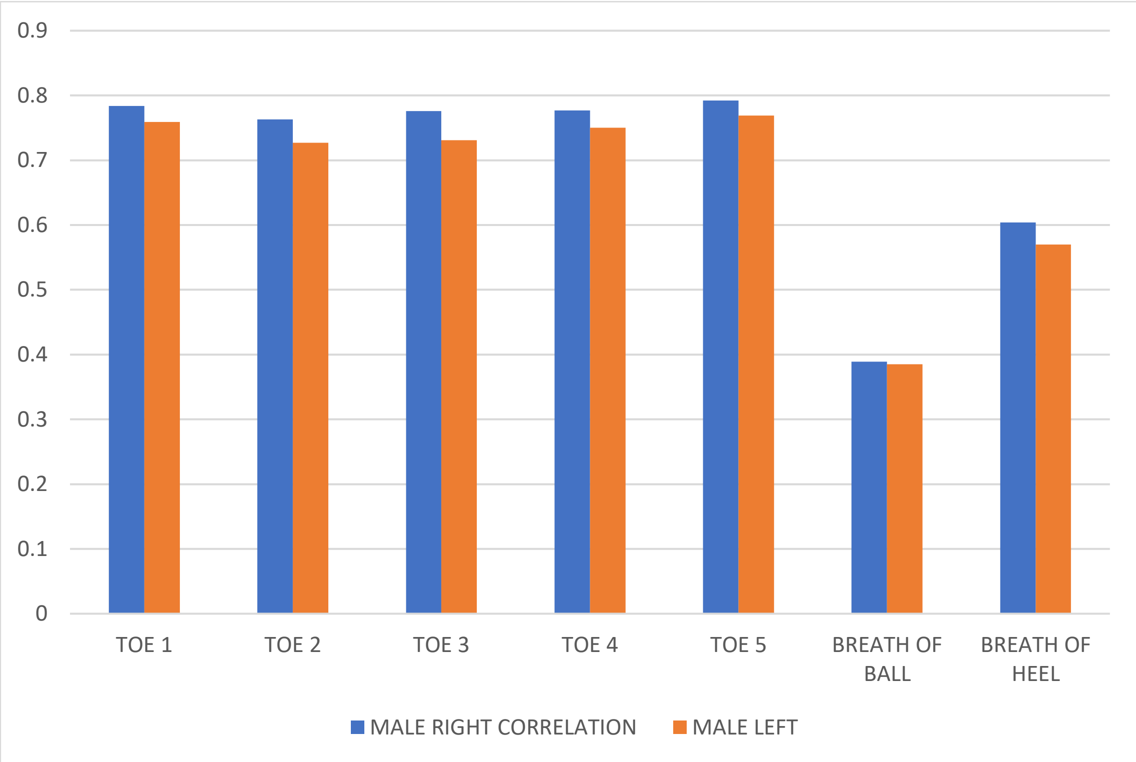
Correlation between the male stature and heel to toe 1, heel toe 2, heel toe 3, heel to toe 4, hell to toe 5, breath of ball, breath of heel of right, footprint shows a P value <0.001 hence it is highly significant. Correlation between the male stature and right footprint shows a P value <0.005 hence it is significant. Correlation between the male stature and right footprint shows a P value >0.005 hence it is not significant.

Table 4: correlation between stature and male left footprint.

S.NO:	PARAMETERS	NUMBER: OF SAMPLE	PEASON CORELATION VALUE	T-VALUE	SIGNIFICANCE& P VALUE
1.	HEIGHT& TOE 1	50	0.784	8.768	0
2.	HEIGHT& TOE 2	50	0.763	8.198	0.001
3.	HEIGHT& TOE 3	50	0.776	8.535	0.001
4.	HEIGHT& TOE 4	50	0.777	8.564	0
5.	HEIGHT& TOE 5	50	0.792	5.517	0.0001
6.	HEIGHT& BREATH OF BALL	50	0.389	2.933	0.005
7.	HEIGHT& BREATH OF HEEL	50	0.604	5.261	0.004

Correlation between the male stature and heel to toe 1, heel toe 2, heel toe 3, heel to toe 4, hell to toe 5, breath of ball, breath of heel of left footprint shows a P value <0.001 hence it is highly significant. Correlation between the male stature and left footprint shows a P value <0.005 hence it is significant. Correlation between the male stature and left footprint shows a P value >0.005 hence it is not significant.

Graph 2: correlation between stature and male footprints.
MALE RIGHT AND LEFT FOOTPRINT CORRELATION WITH STATURE



IV. RESULT

Female footprint findings

Correlation between the female stature and, heel to toe 1, heel to toe 2, heel to toe3, heel to toe 4, heel to toe 5, breath of ball, breath of heel left footprint shows a P value < 0.001 hence it is highly significant. Correlation between the female stature and left footprint shows a P value <0.005 hence it is significant. Correlation between the female stature and heel of left footprint shows a P value >0.005 hence it is not significant.

Correlation between the female stature and heel to toe 1, heel to toe 4, heel to toe5, breath of ball, breath of heel of right footprint shows a P value <0.001 hence it is highly significant. Correlation between the female stature and right footprint shows a P value <0.005 hence it is significant. Correlation between the female stature and heel to toe2, heel to toe3 of right footprint shows a P value >0.005 hence it is not significant.

Male footprint findings

Correlation between the male stature and heel to toe 1, heel toe 2, heel toe 3, heel to toe 4, hell to toe 5, breath of ball, breath of heel of right, footprint shows a P value <0.001 hence it is highly significant. Correlation between the male stature and right footprint shows a P value <0.005 hence it is significant. Correlation between the male stature and right footprint shows a P value >0.005 hence it is not significant.

Correlation between the male stature and heel to toe 1, heel toe 2, heel toe 3, heel to toe 4, hell to toe 5, breath of ball, breath of heel of left footprint shows a P value <0.001 hence it is highly significant. Correlation between the male stature and left footprint shows a P value <0.005 hence it is significant. Correlation between the male stature and left footprint shows a P value >0.005 hence it is not significant.

According to this study, the correlation between the stature and measured footprints parameters shows the significant level of correlation so that it can be used to calculate regression equation for estimate of stature using footprint.

Male have larger foot dimensions then female. males have the most significant level of correlation between the stature and the footprint dimensions compare with females.

V. DISCUSSION

The present study explored the relationship between an individual's stature and various dimensions of their footprints, aiming to develop regression models for stature estimation from footprint measurements. The findings suggest a statistically significant correlation between footprint parameters and stature, reinforcing the potential forensic value of footprints in human identification. Specifically, in both male and female participants aged 15–25 years, notable correlations were observed between stature and the lengths of the toes (particularly toe 1 and toe 5), as well as the breadth of the ball and heel of the foot. For females, toe lengths on the left footprint exhibited stronger correlations with stature, while in males, both the right and left footprint dimensions demonstrated significant predictive capacity, particularly toe 5.

The data support previous research, which consistently highlights the utility of footprint dimensions in estimating stature across different populations. However, variations in correlation strength between genders and foot sides emphasize the need for population-specific equations. The significance of the correlation, particularly with the first and fifth toes, aligns with earlier anthropometric findings, suggesting these parameters as reliable indicators of stature.

Despite the study's promising findings, limitations such as small sample size and manual measurement methods may affect data precision. Future research involving a larger, more diverse sample and digital measurement tools could enhance accuracy and reliability. Overall, the study demonstrates that footprint analysis, particularly in forensic contexts, can aid in narrowing down suspect profiles and contribute to personal identification when other biometric data are unavailable.

VI. CONCLUSION

The present study has effectively demonstrated a significant correlation between footprint dimensions and human stature, establishing footprints as a reliable anthropometric indicator for stature estimation. By analyzing both male and female footprints of individuals aged 15 to 25 years, the research confirmed that various footprint parameters especially the heel-to-toe lengths and the breadths of the ball and heel are significantly related to an individual's height. The use of Pearson correlation and Regression analysis provides statistical validation for these findings, aligning well with prior studies conducted across diverse populations.

Footprints, often overlooked, hold immense forensic value, especially in crime scene investigations where other biometric evidence such as fingerprints or DNA might be absent or degraded. Through this study, it was observed that male participants generally exhibited stronger correlations and larger foot dimensions compared to females, reinforcing known biological differences between sexes. Among the footprint parameters, the lengths of toe 1 and toe 5 proved to be the most consistently predictive of stature across both genders, making them crucial indicators for forensic assessments.

The regression models derived from the analysis can serve as practical tools in forensic investigations to estimate stature from partial or complete footprints. This approach could greatly assist in the identification of unknown individuals, especially in mass disaster scenarios or crime scenes where traditional methods are not applicable.

In conclusion, this research underscores the forensic importance of footprints, supports their utility in stature estimation, and emphasizes the need for continued exploration in this domain to enhance accuracy, reliability, and applicability in real-world forensic contexts. With further refinement and validation, footprint-based stature estimation can become a standard component of modern forensic protocols.

VII. RECOMMENDATION

- The Present study has identified some limitations such us manual measurement techniques and ink-based footprint collection introduced potential inconsistencies in data accuracy. Additionally, the relatively small sample size and narrow age range may limit the generalizability of the findings to broader populations. Further research suggested to expand the demographic scope and incorporate digital measurement technologies for improved precision.

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