Original Article

Stature Estimation Using Percutaneous Tibial Length Between Male and Female Cadavers in Lahore

Correlation Coefficient Between Tibial Length and Body Stature

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ABSTRACT

Objective: The main objective of this study is to determine the correlation coefficient between tibial length and body stature (body length).

Study Design: comparative cross-sectional study

Place and Duration of Study: This study was conducted at the Forensic Medicine & Toxicology Department of KEMU, Lahore from August 2019 to February 2020.

Methods: In this study, percutaneous tibial length was measured along with body length in 64 dead bodies (32 male & 32 female). It was a comparative cross-sectional study. Non-probability consecutive sampling technique was used. It was carried out in the Forensic Medicine & Toxicology Department of KEMU, Lahore.

Statistical Analysis: Data was analysed by using SPSS version 26. Correlation coefficient was calculated between percutaneous tibial length and body length of dead bodies.

Results: Pearson correlation coefficient was 0.930 & 0.889 in males and females respectively. Very strong statistically positive and significant results were found.

Conclusion: The link of association of percutaneous tibial length with body stature is remarkably strong. This enables accurate estimation of height in deceased persons. Identification of cadavers was aided with the help of a developed regression equation for estimation of height.

Key Words: Stature Estimation, Percutaneous Tibial Length, Forensic Anthropology and Cadavers

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INTRODUCTION

The need to identify oneself as an independent individual is probably one of the primal instincts of human nature. It is an inborn desire to self-awareness, an innate sense of individuality to identify consciousness and personal experiences.[1] This individualization helps in interactive relationships including alliances of social network whether it be familial or work related.[2] Expanding the explorative need for identification opens up the civil as well as the medicolegal debate of why absolute identification is mandatory.[3] Medical care requiring blood group analysis, diagnosis and management of individual diseases is a cardinal aspect of identity establishment.[4]

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Social linkage demands identity as a requirement in civil cases like inheritance, inherent lineage and cultural heritage.[5] How and when can a person vote, what is the legal age for any job, what is the legal age of majority entitling someone for a capital punishment, how to track criminal activity, all these issues fall under the purview of an identification of a person. All this protocol builds up for prevention of any law and order scenario like impersonation, theft, fraud and tracking a murderer or a rapist in heinous crimes.[6] The phenomenon of corpus delicti can only be put in place through personalization, that is proving the crime committed by a specific criminal fellow. Besides this identification is a pivotal factor in cases of unknown dead bodies or in cases of mass disaster where at times only body parts are available, which need to be identified for not only provision of closure to the family but also to settle legal matters like solving a murder or issuance of monetary compensation regarding either insurance claims or consolation cash to the relatives of the deceased victims issued by the authorities. Hence either the unknown mutilated bodies, decomposed dead individuals, mass disaster related body parts either belong to a male individual or a female victim is the main objective of this research study project. How to differentiate male from female especially in cases of

body parts like upper or lower limbs only or from the human skeletal remains.[7]

Among all the biological parameters body stature has a significant role in identifying personal individuality and for the research purpose of this study Percutaneous Tibial Length is the variable to be studied for a stature calculative differentiation between a male and a female individual. Percutaneous tibial length is length of tibia measured from skin surface which has a significant positive correlation with stature (height) of a human being, meaning that as percutaneous tibial length increases so does stature tends to increase.[8]

Stature estimation is a fundamental aspect of forensic anthropology, aiding in the identification of individuals in cases involving fragmented or dismembered remains.[9] The tibia, being one of the most robust and accessible long bones, has been widely studied for its correlation with stature.[10] Percutaneous tibial length (PCTL) offers a non-invasive measurement method, making it particularly useful in forensic and medicolegal contexts. Research has consistently demonstrated that lower limb dimensions, including tibial length, are among the most reliable predictors of stature due to their strong correlation coefficients ($r > 0.8$) and minimal error margins.[11]

Population-specific formulas are crucial for accurate stature estimation, as hereditary and environmental factors significantly influence body proportions. Studies on Han populations in southern China have shown that regression equations developed for one group may not apply to others due to ethnic variations.[12] Similarly, secular changes and urbanization have impacted generational height trends, necessitating updated regression models tailored to specific regions.[13] Despite advancements in forensic methodologies, there remains a lack of contemporary data for South Asian populations, particularly in Pakistan. This study aims to address this gap by analysing sexual dimorphism in tibial-stature relationships among male and female cadavers from Lahore.

By developing localized regression equations based on PCTL measurements, this research seeks to enhance the accuracy of stature estimation protocols for Punjab's unique demographic profile. Such findings will contribute to forensic anthropology databases and improve identification processes in medico-legal investigations.

METHODS

It was a comparative cross-sectional study. The study was conducted in the Department of Forensic Medicine & Toxicology, KEMU, Lahore. The study was completed in one year after approval of the synopsis. 32 Males and 32 Females dead bodies aged between 20-50 years. Non-probability consecutive sampling was used. Dead bodies with healthy normal limbs without any deformity or disease (local skin disease, ulcer). Ages between 20-50 years were included in this study. Percutaneous tibial length is the total length of tibia significantly presenting the distance between the medial most superficial points on the upper border of the medial condyle to the superficial lower most point of medial malleolus of tibia. Both points were marked. By spreading caliper at these points length of tibia was taken in centimeters. Dead body length (body stature) was taking on the autopsy table. The dead was put on the autopsy table straight unbent legs and other parts of the body. Feet were put together. With a marker a line was made on the table at the top of the head. Another line was made on table at the heel. Then the distance between those lines was measured in centimeters.

Statistical Analysis: Data was analyzed by SPSS version 26. Descriptive data were expressed as maximum, minimum, mean and standard deviation. Pearson correlation coefficient for male, female and overall was derived between tibial length and dead body stature.

RESULTS

In the current study, 64 cadavers were brought to the mortuary of the Forensic Medicine & Toxicology Department of KEMU, Lahore. Descriptive data of body stature and tibial length of overall samples as shown in *Table 1*. Maximum, minimum and mean values of tibial length were 51, 29 and 43.41cm and the standard deviation was ± 7.59cm. Minimum, maximum and mean body stature were 179,133 and 159.23 cm and SD was ±19.77.

Table No.1: descriptive statistics results of study participants.

Variable	Minimum	Maximum	Mean±SD
Tibial Length	29	51	43.41±7.59
Body Stature	133	179	159.23±19.77

The correlation coefficient between tibial length and body stature in males was 0.930 with p value <0.001 and in females was 0.889 with p value of <0.001, as shown in Table 2.

Table No.2: Correlation coefficient between tibial length and body stature.

Variables	Male		Female	
Tibial Length & Body Stature	Co-efficient	p-value	Co-efficient	p-value
	0.930	<0.001	0.889	<0.001

The regression equation calculated between tibial length and the stature of the body was $63.12 + 2.34\ Tibial\ length\ (X)$.

DISCUSSION

Percutaneous tibial length is length of tibia measured from skin surface has a strong correlation meaning that as percutaneous tibial length increases so does height. Multiple studies across different regions of the world including both males and females show a consistent statistically significant, positive correlation between percutaneous tibial length and stature. Correlation coefficient (r) often ranges from 0.69 to 0.94 which is suggestive of moderate to strong interactive relationship and this correlation tends to be stronger in males compared to females within the same population, however this can vary significantly between different populations, ethnicities, and even geographical regions.[14]

The relationship between percutaneous tibial length and stature is often modelled using linear regression equations. Equation for estimation of stature is: Stature = a + b × (Percutaneous Tibial Length) where 'a' is a constant (intercept) and 'b' is the regression coefficient (slope). These constants and coefficients are determined empirically for specific populations and sexes.[15]

In forensic related cases where only skeletal remains or fragmented body parts are found, forensic doctors use these correlations and population-specific regression equations to estimate the stature of the deceased, aiding in identification.[16]

The current study required to establish a correlation between percutaneous tibial length and stature among cadavers aged 20 to 50 years from the Lahore population. Our findings indicate a strong positive correlation between tibial length and body stature, with correlation coefficients of 0.930 for males and 0.889 for females ($p < 0.001$ for both). The derived regression equation, Body Stature (Y) = 63.12 + 2.34 Tibial Length (X), underscores the predictive value of tibial length in estimating stature within this demographic.

These findings are in accordance with some others carried out in adjacent areas. Such as, a study conducted on Nepalese medical students found significant relationships between height and percutaneous tibial length, having regression equations of 104.80 + 1.81 Tibial Length for males and 93.58 + 1.91 Tibial Length for females.[17] Also, studies conducted with the Bengali ethnic group showed a strong correlation between standing height and tibial length, highlighting the importance of tibial measurements for estimating height.

Under the Mediterranean umbrella, an Italian population study created new regression models for estimating height from tibial length, noting the need for population-specific formulas because of differences in body proportions across regions.[18] Moreover, studies among Acehnese ethnic group in Indonesia showed strong (r = 0.81) correlation between tibial length and height, which further confirms the usefulness of tibial measurements for estimating height.[19]

With so many global studies available, surprisingly, not much attention has been paid to the Pakistani Population. This study aims to fill the gap by presenting accurate data that can be used anthropologically or forensically, without further analysis of larger samples representing different regions.[20]

In conclusion, the strong correlation between percutaneous tibial length and stature observed in this study reinforces the tibia's role as a reliable predictor of stature. These findings contribute valuable data to the field of forensic anthropology in Pakistan and underscore the need for continued research to refine and validate stature estimation models tailored to specific populations.

CONCLUSION

The importance of establishing uniqueness in the medicolegal system, emphasizing the estimation of an individual's height as a key method for positive identification. It highlights that various body parts can be used for estimating stature, and presents findings showing a strong positive correlation between percutaneous left tibial length and body stature. The study concludes that a regression equation can be developed to estimate height in deceased individuals based on tibial length.

The conclusive inference drawn from this research study is that there is a linear correlation between the length of tibia and the height of an individual and this is also specific to male and female gender respectively. These numerical calculations can be charted according to ethnicity, gender and geographical areas which can later be used for identification purposes in case of any mass disaster or where fragmented body parts are brought in by the police for post mortem examination and identification.[24]

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Riasat Ali, Ahmad Raza Khan, Fariha Tariq
Drafting or Revising Critically:	Khalid Mahmood, Aatiqa Abbas, Noreen Kashif
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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