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Research Paper

Body Height Estimation Based on Tibia and Femur Length in Different Stature Groups

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ABSTRACT

Stature provides one aspect of an individual's physiognomy and one piece of information that may be an aid in individual identification. Most methods of estimating stature from the skeleton are based on the long bones of the upper and lower extremities. Others deal with stature estimation from parts of the skeleton, either single bones or combinations of bones. Yet others estimate stature from incomplete bones, normally parts of long bones. Length of femur and tibia can be measured with the help of the Vernier caliper. Bones recovered in forensic situations may either have been lying on the surface, in the ground, or in water. The six long bones of the skeleton are generally composed of a shaft forming a tube of compact bone with a marrow cavity along the middle of the tube, whereas the interior of the bone ends has a rigid, spongy structure, covered by a thin layer of compact bone. Stature increases during childhood and through puberty until all bone growth has ceased after puberty.

Keywords: *Body Height Estimation, Tibia and Femur Length, Stature Groups*

The study of skeletal remains for the sake of identification is referred to as forensic anthropology. The age, sex, race, and antemortem height of the unknown person are all determined in a standard forensic anthropological examination. The anatomical or mathematical methods are frequently used to estimate stature. The anatomical approach is used to calculate the total skeleton height. The mathematical approach, on either hand, estimates the individual's stature by using one or even more bone lengths. The obvious benefit of this method is that it can determine an individual's stature using just one bone.

The fundamental drawback of the mathematical method is that multiple regression formulae are needed for different populations, different bones, and different sexes. This is due to the fact that body proportions vary by population and sex, making these equations demographic and sex-specific (1). The strongest indication of stature is the length of the long bones. It is known, however, that the long bone length/height ratio varies with the stature to some extent. The tibia is a common long bone used to determine stature. The ratio of tibia length to body height has been seen to differ between populations and even individuals (2). In the human body, the femur is the longest and most powerful bone. Estimating stature from the

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femur has a direct correlation, so most of the time, police/investigating authorities bring parts of the femur to forensic specialists rather than the full bone. It becomes more difficult to identify a person using only femur pieces, hence a regression equation for estimating stature from femur fragments must be developed (3).

When estimating the length of the bones for stature estimation, one of the most significant issues is that shorter people are taller than they really are, and tall people are shorter than they are. As a result, rather than using a single generic formula, stature-group-specific formulas for small, moderate, and long statures are one of the recommended ways for reducing mistakes in stature assessment. The greatest contributor to stature is the lower extremities' long bones. In the same way that the femur is measured, the tibial length is measured. More than any other long bone, the estimation of stature is important. This is due to the ease with which the tibia may be accessed and the length of the tibia (4).

There are several ways for estimating stature from various body parts; the majority of them evaluate upper and lower limb bones, such as the metatarsal, foot, tibia, femur, ulna, upper arm, hand, finger, and phalange lengths. Some investigations used bony parts, while others relied on soft tissue measures and radiographic techniques. Human height increases from conception to 20-25 years of age, then decreases by 2.5 cm every 25 years after 30. Due to the obvious ancestral and ethnic disparities that exist in different parts of the world, population-specific research places a premium on assessments of stature (5).

The length of each long bone fragment and the entire length of the bone were measured, and the ratio between every fragment and the overall length of a bone was determined. The treatment of severely comminuted distal femur fractures is very difficult. It can be difficult to achieve appropriate attachment, especially when many fragments are present (6). Stature is a unique biological feature that may be assessed not only in the living but also in the skeleton of a person long after they have died. The measures are based on the adult bones' maximum length. And forensic anthropological analysis for the purpose of identification includes the reconstruction of stature from the accessible skeletal remains (7). Personal identity relies on anatomical characteristics such as stature. Identification of unknown individuals and determining why they died are crucial in forensic anthropology (8). The greatest contributor to stature is the long bones of the lower extremities. The assessment of tibial length, like that of the femur, aids in proper diagnosis. More than any other long bone, the evaluation of stature (9). The population from which the equations were created should yield the most precise results for determining stature. As a result, each population should: their own regressions using a sample of recent data to account for any secular trends in stature in the population (10). Anatomical and regression methods are used to estimate stature. To estimate life stature, the anatomical technique originally required a virtually complete skeleton, with height measurements of each bone from the head to the calcaneus (heel) combined with soft tissue adjustments (11). Incomplete fragments can be used to determine the height by first calculating the total length of the bone using a regression equation and then applying it to the incomplete fragments as the first formula for calculating stature (12).

One of the four demographic features of the biological profile that may be determined from skeletal remains is stature, which is one of the foundations of human anthropological identification. The estimation of stature aids forensic anthropologists in identifying individuals of unknown identity by narrowing down the available matches and facilitating positive identification (13). The mathematical method is mostly based on regression analysis, a statistical theorem. Individual measurements or combinations of measurements of complete and fragmentary skeletal bones, as well as percutaneous bones, are used to create regression equations (14). A "certain number of the bones" were remeasured in the "dry state" 8 or 10 months later, and it was discovered that they had lost on average 2 mm of length (15). Many studies have recently been conducted to aid in the estimate of stature in various countries. In addition, various studies have been carried out in Iran. However, we were unable to locate any research. Few authors have addressed the tibia in this manner in comparison to the femur when estimating stature (16). Although a number of bones were used to reconstruct size, the restoration of stature using long bones, particularly those of the lower limbs, appears to be the most common and effective is said to deliver near-perfect results (17). Individual identification based on stature estimation has a significant impact in a variety of medico-legal examinations and can be used in mass shootings catastrophes. Because lower limb length is significant in determining an individual's standing height, most prediction models are based on the length of the tibia, femur, and fibula. Tibia is easy to measure in the living population because it is placed subcutaneously (18). When using fragment-based approaches, the bone length is calculated first, and then the calculated bone length is utilised to determine stature, compounding any errors (19). In palaeoanthropology and osteoarchaeology, determining body mass and stature are critical steps in the appraisal of skeletal remains, as well as crucial components of personal identification in forensic cases. Body mass and stature are typically calculated using independent variables like long bone lengths in equations that indicate the linear relationship between the skeletal variable and body weight or stature (20). An individual's stature is a natural trait. It is one of the most significant characteristics for determining a person's identity. There is a problem establishing a link between stature and physical dimensions. Forensic experts can determine the value of certain body parts' stature derived from several areas of the body (21). Several workers have attempted to estimate height by measuring various long bones, with varying degrees of success. Pan did a thorough study on estimating stature from long bones, including the tibia (22). "Morphometric" approaches to estimating body mass try to recreate body size and shape directly from preserved skeletal parts. With certain caveats, estimated stature paired with measured biiliac (maximum pelvic) breadth has been found to yield appropriate body mass estimations across a wide range of current human populations (23). Estimating the stature of mutilated human body fragments is a typical practice for human identification. In this instance, stature is frequently computed using linear regression models based on measurements of long bones of the limbs, assuming a linear relationship between long bone size and living stature (24). Only people with complete femur lengths (including proximal and distal epiphyses) and statures can be determined using the femur stature ratio as stated (25). The anatomical technique adds the height of the head, the height of the vertebral column, and the length of the lower limb (including the talus and calcaneus), as well as a soft tissue adjustment factor. Stature is estimated using mathematical approaches employing equations that reflect a linear relationship among stature and the variable, such as long bone lengths (s) (26).

Stature Estimation from Bones of South African Whites

The reconstruction of stature from skeletal remains is an aspect of the project. Forensic anthropological examination with the purpose of identifying a person. The goal of this research was to come up with a regression formula. Formulae for calculating total skeletal height and, after that, equations for calculating total skeletal height. Long bone lengths can be used to predict tall in white South Africans. There were 98 white male skeletons and 71 white woman skeletons in the sample. The Pretoria Bone Collection is a collection of bones from Pretoria, South Africa. Total skeleton heights for each individual and the maximum lengths of long bones were determined and used to create univariate regression equations, with correlations (r) ranging from 0 to 1, in the range of 0.56 to 0.96. The lumbar spine, femur, and tibia were combined to produce the lowest standard error of estimate (1.75 for females, 1.92 for males), while the lumbar spine alone produced the greatest SEE (5.21 for females, 5.54 for males). Corrections for soft tissue additions to obtain living height from total skeleton height have just been published, making these equations more practical and reducing the problem of underestimation. The resulting formulas are population-specific and intended for use in forensic skeleton investigations of South African whites, but they are also broadly applicable to theoretical and practical forensic anthropology challenges (1).

Body Height Estimation Based on Tibia Length in Different Stature Groups

One of the most well-known indices of human size is the length of the long bones. Despite the fact that the long bone length/height ratio varies between tall and short people, no research has looked at whether specific formulae should be employed to assess height in various stature groups. This paper provides a novel approach for estimating height. 121 male volunteers ranging in age from 18.0 to 34.3 years old had their body length and tibia length measured. The 15th and 85th percentiles were used as cut-off thresholds for three subgroups based on body height (short, medium, or tall). To estimate height in each subgroup, a generic formula and a group-specific regression formula were utilized. The same procedures were used to analyze a control group with the same properties as the research group. The discrepancy between genuine height and predicted height using group-specific equations was smaller than that of the difference observed when the general equation was applied, especially with "short" and "tall" people. There was a statistically significant difference between the two groups. When determining height from tibia length, take into account the individual's general stature category, and utilize group-specific equations for short and tall people (2).

Estimation of Stature from Fragments of Femur

Anthropology and forensics both benefit from the estimation of stature from the bone. The goal of this work is to estimate the length of the femur using femur bone fragments, such as intertrochanteric crest length, the transverse diameter of the head, and bicondylar breadth, and then to calculate stature from the femur length. In comparison to the others, the transverse diameter of the skull has a statistically significant value. As a result, in the current work, we can estimate femoral length from femoral fragments using a regression equation, and then determine stature from the femur length (3).

Stature Estimation Based on Tibial Length in Different Stature Groups of Spanish Males

It is well understood that secular trends have an impact on human stature and constitution, and this fact should be considered in forensic anthropology, particularly when estimating stature. To account for these differences, stature-group-specific equations have recently been created. The goal of this study is to improve the accuracy of earlier equations by estimating living stature based on tibial length in distinct height groups in a sample of Spanish adult males. Stature estimate is more accurate using stature-group-specific equations based on tibial lengths of Spanish adult males than with other equations developed in the Spanish population. When estimating height in forensic contexts, it is recommended to utilize regression equations unique to stature groups (4).

CONCLUSION

Several studies have concluded that estimation of body height is based on tibia and femur bone length. For all metatarsal measurements other than the femoral head diameter, correlations between metatarsal size and femur length were lower than their equivalents for femoral head diameter based on length (20). The obtained regression method can be used to estimate height from the tibia bone in the South Indian population (18).

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Conflict of Interest
The author declared no conflict of interest.

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