ESTIMATION OF HEIGHT USING HEAD CIRCUMFERENCE OF MEDICAL STUDENTS IN PESHAWAR, PAKISTAN

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ABSTRACT

Objectives: To ascertain whether head circumference can be utilized to estimate stature in students from the medical college in Peshawar.

Methodology: In this study, we aimed to investigate the relationship between height and head circumference in a cohort of first-year students from a public medical college. The sample comprised 140 participants, evenly split between 70 males and 70 females, with ages ranging from 18 to 20 years. For height measurement a stadiometer was used, and a measuring tape was used to gauge head circumference. Regression equation was used to analyze the data for estimating height from circumference of head.

Results: In this study, the average height of males was determined to be 174.860 cm with a standard deviation of 5.745 cm, while the average head circumference was 54.926 cm with a standard deviation of 1.590 cm. Conversely, females exhibited an average height of 160.842 cm with a standard deviation of 5.540 cm, and an average head circumference of 53.245 cm with a standard deviation of 1.286 cm.

Conclusion: In conclusion, our study underscores the significance of head circumference as a reliable indicator for assessing stature in both males and females. The observed significant relationship between head circumference and height in both sexes suggests that head circumference can serve as a robust parameter for estimating height. These findings contribute to the field of anthropometry, providing practical implications for height estimation based on head circumference, and may have relevance in diverse contexts, such as clinical assessments or population studies.

Keywords: Human Stature; Head Circumference; Forensic Anthropology; Linear Regression.

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INTRODUCTION

One fundamental and practical anthropometric factor that establishes a person's physical identity is their body height or stature.[1] The determination of sex, origin and natural height is called forensic identification. The use of scientific methods and procedures for legitimate purposes comes under the scope of Forensic Medicine.[2,3]

Each component of the human body such as the face, head , trunk, and limbs, is biologically related to stature in a clear and proportionate manner.[4,5] Body long bones have traditionally been used to estimate height from skeletal remains. A forensic scientist can use this relation to determine height from severed and disfigured body parts during forensic investigations.[6]

Estimating a person's height from a decaying, partial, or disabled body has significant forensic implications. From such a cadaver, forensic experts typically need to know the deceased's height.[7] Both forensic experts and anatomists require anthropometry work of the skeleton from numerous biological structures for the appraisal of stature.[8]

The stature of different populations in relation to skull and jaw dimensions has been frequently recorded.[7] The evaluation of a person in a major calamity is aided by the calculation of a person's height.[9]

Various studies have been conducted in diverse populations worldwide to estimate individuals' height based on different anatomical measurements. In the United States, researchers have explored the determination of height using measurements of the human skull and teeth.[7] Meanwhile, in India, studies have focused on estimating stature from head circumference measurements,[10-14] as well as from head dimensions in South-South Nigeria[15] and South India.[16]

Bangladeshi Garo adults have been a subject of research for stature estimation using head measurements, while in Bangladesh, height determination has been investigated through hand print dimensions.[17,20] Forearm measurements have also been employed for height estimation in certain populations, along with studies utilizing maxilla and facial measurements. Additionally, investigations into height determination have extended to measurements from the hands and feet.

Measuring height can be challenging in situations where just a few pieces or fragments of a human body are discovered, such as after bomb blasts, plane crashes, earthquakes, and animal-mutilated bodies. In these circumstances, the stature may be precisely calculated from the accessible body parts using the regression equation.[23]

While previous research has explored various methods for estimating stature, there is a limited body of work specifically focusing on stature estimation solely from head measurements.[11,20] Recognizing the inherent variability across populations, it is crucial to acknowledge that results obtained in one demographic may not be universally applicable to others. This underscores the necessity for systematic studies tailored to specific regions to ensure the reliability and accuracy of height estimation methodologies. In response to this gap in research, the present study aims to address the dearth of information on stature estimation from head anthropometry in a particular region.

The primary objective of the current study is to establish a comprehensive understanding of the relationship between an individual's height and head circumference within the context of the Pakistani population. Through rigorous investigation, the research endeavors to unveil patterns and correlations that would allow for the development of reliable regression equations. These equations, in turn, can be utilized as practical tools to estimate stature based on head dimensions. By undertaking such a region-specific study, the research contributes valuable insights into the science of anthropometry, offering a tailored approach to stature estimation in the Pakistani demographic.

METHODOLOGY

This cross-sectional observational study was conducted over the duration of April 1st to April 30th, 2023, subsequent to obtaining ethical approval. The study enrolled a total of 140 first-year students (70 males and 70 females), aged between 18 and 20 years, from a public medical college. Informed consent was secured from participants, who were selected to represent a diverse range of religious and geographic backgrounds. Notably, individuals with any pre-existing illnesses or physical abnormalities were excluded from the study to ensure the health and homogeneity of the sample.

Anthropometric measurements, crucial for the investigation, were meticulously obtained in centimeters. Stature was assessed using a standing height measuring frame (Stadiometer), capturing the distance from the heel to the vertex while participants stood upright. Simultaneously, head circumference was measured using a non-stretchable plastic tape, carefully threaded through the opisthocranio, the area just above the eye ridges, from glabella to glabella.

The collected data, comprising height and head circumference measurements, were organized into tables for subsequent analysis. IBM SPSS Statistics Version 23 was employed for statistical analysis, specifically for calculating linear regression equations. This analytical approach aimed to unveil the relationship between height and head circumference within the study population.

Ethical considerations were paramount throughout the study, with ethical approval obtained and informed consent prioritized. The research adhered to ethical standards to safeguard participant privacy and confidentiality. The robust methodology employed in this study ensures the reliability and relevance of the obtained anthropometric data, contributing valuable insights into the relationship between height and head circumference among first-year students in a medical college setting.

RESULTS

In our study, a cohort of 140 first-year students, evenly distributed between 70 males and 70 females, aged 18 to 20 years, underwent comprehensive anthropometric measurements. For males, the observed stature ranged from 158.40 cm to 190 cm, reflecting a considerable variability within the cohort. The average height for males was determined to be 174.860 cm, with a standard deviation of 5.745 cm, providing a measure of the overall dispersion from the mean. Head circumference in males ranged from 51.90 cm to 59.20 cm, exhibiting variability, and the average head circumference was 54.926 cm, with a standard deviation of 1.590 cm. For females, the average height ranged from 143.90 cm to 173.80 cm, reflecting a diverse range within the female subgroup. The mean height for females was 160.842 cm, with a standard deviation of 5.540 cm. Head circumference in females varied from 49.8 cm to 56 cm, with an average of 53.245 cm and a standard deviation of 1.286 cm, indicating the extent of variability within the female cohort. These findings underscore the heterogeneity in both height and head circumference within the studied population. The observed range and standard deviations provide a comprehensive picture of the distribution of anthropometric measures, crucial for understanding the diversity in physical characteristics among first-year students aged 18 to 20 years (Table 1 & 2).

Among study cases, there were 70 female and 70 male students, range and average height of males and females are shown in table 1, and head circumference of both sexes. The association between the height and head circumference, was found using Pearson's coefficient of correlation. Height and head circumference have a considerable correlation (Table 2).

Regression equations for estimating stature were produced by doing a linear regression analysis on the given data. Regression Equations are calculated using the formula Stature ST = (a) + (b) x HC. Where (a) is value of constant, (b) is regression coefficient and HC is head circumference. By utilizing this regression equation, we can predict the estimated stature for an individual based on their head circumference. This modeling approach enables a quantitative understanding of how changes in head circumference relate to changes in stature, providing a valuable tool for estimating stature in the studied population. The derived regression equations serve as a practical and data-driven method for height estimation, contributing to the broader field of anthropometry.

Pearson's correlation coefficient was employed to examine the relationship between height (stature) and head circumference (HC) in the studied population. The results, as presented in Table 2, revealed a significant correlation between height and head circumference. For the entire cohort, the correlation coefficient (r) was 0.568, with a corresponding p-value of 0.000, indicating a robust positive correlation. When considering gender-specific analyses, the correlation coefficient for male subjects was r = 0.36 (p = 0.001), and for female subjects, it was r = 0.24 (p = 0.001). These results underscore the positive and statistically significant association between height and head circumference in both males and females. To assess the practical utility of the derived regression equations, a comparison between estimated height and actual stature was conducted, as outlined in Table 3. The findings indicated no significant differences between the projected stature using regression equations and the actual measured stature. This suggests that the regression equations provide an accurate estimation of stature based on head circumference. Therefore, our study concludes that the developed regression models can reliably predict stature from head circumference with a high degree of accuracy, offering valuable insights for height estimation in both male and female populations.

DISCUSSION

Our study consists of 140 first-year students (70 males and 70 females) age 18 to 20 years, male's stature ranged between 158.40 cm to 190 cm, with an average height of 174.860 cm ± 5.745 cm SD. The head circumference was between 51.90 cm

Table 1: Distribution of Head circumference and Heights Among Study Participants, Detailing Range and Average Height for Both Male and Female Students (N=140).

Measures			Average	SD
Head circumference	Male	54.926 ± 1.590	53.245 ± 1.286	54.455 ± 1.700
	Female	174.860 ± 5.745	160.842 ± 5.540	168.256 ± 9.286
Height	Male	54.926 ± 1.590	53.245 ± 1.286	54.455 ± 1.700
	Female	174.860 ± 5.745	160.842 ± 5.540	168.256 ± 9.286

Table 2: Statistical analysis of head and height dimensions

Parameter	Male		Female		Male & Female	
	Values In (Cm)	Height	Head Circ	Height	Head Circ	Height
Values in (cm)	51.90-59.20	158.40-190	49.8- 56.0	143.90- 173.80	49.8-59.20	143.90-190
Average	54.926	174.860	53.245	160.842	54.455	168.256
SD	± 1.590	± 5.745	± 1.286	± 5.540	± 1.700	± 9.286
Correlation (r)	(r)= 0.36, P = 0.001		(r) = 0.24, P = 0.001		(r)= 0.568, P = 0.000	
Reg Co-efficient (b)	3.086		1.364		1.10	
Constant of Reg equation (a)	-4.681		98.788		100.984	

Table 3: Comparison of measured and estimated statures based on head circumference.

	Stature estimation via reg equation		P- value showing significance of estimated and actual stature
	Variable	Range in cm	Mean ± SD
Male	154.890 - 183.022	175.933 ± 2.250	0.983 - (No significance)
Female	171.606 - 181.148	161.092 ±1.461	0.971 - (No significance)
Combined	157.336-164.551	168.237 ± 5.407	0.996 – (No significance)

and 59.20 cm, with an average of 54.926 cm ± 1.590 cm of SD. The average height of females varied from 143.90 cm to 173.80 cm, with an average of 160.842 and a SD of 5.540 cm, while the average head circumference was from 49.8 cm to 56 cm with a mean of 53.245 ± 1.286 cm SD.

Various studies has been conducted on relationship between height and head circumference of an individuals. In the present study height and head circumference found to have a considerable correlation.

A study by Prenetha has reported that head circumference has a moderate link with assessing stature in both sexes.[10] Shah and his colleagues have discovered a significant positive relation between head circumference and stature. ($r= 0.575$, $P = 0.000$) for both, ($r=0.38$, $P=0.001$), and ($r= 0.26$, $P=0.001$) for male and female respectively. These findings are similar to those in our study.[11]

In the pursuit of understanding the correlation between stature and skull measurements, Agnihotri et al. found no statistically significant relationship, suggesting a lack of association between these anatomical features.[18] However, contrasting findings were reported by Patil et al., who did observe a significant relationship between stature and the skull.[13] Notably, Patil and Mody utilized radiographic lateral cephalograms of the skull to estimate stature through regression analysis, adding a nuanced approach to the investigation.

Drawing parallels to the current study, Eboh and Ohaju-Obodo discovered a noteworthy relationship between height and head dimensions, indicating statistical significance ($p<0.05$).[15] Their findings, similar to the current research, propose the utility of head dimensions as effective tools for reconstructing an individual's height. The application of simple and multiple regression models in height reconstruction based on head dimensions carries implications in the medico-legal context, showcasing the forensic relevance of such anatomical measurements.

In a parallel investigation by Palak Shah and Lakshmi Thangavelu,[16] a regression equation was established, mirroring our findings, to delineate the correlation between height and head measurement. Their study findings, height of 2.306 + 119.324 (R2 - 0.042), bears a notable resemblance to the regression equation derived in our study. This similarity strengthens the emerging consensus regarding the association between height and head measurements across different studies.

Krishan et al. delved into the correlation between head circumference and stature in 252 male adolescents from northern India.[14] Their investigation revealed a robust correlation coefficient of +0.781, indicative of a very strong positive relationship between height and head circumference, as per Pearson's coefficient. This substantial correlation aligns with our own findings, reinforcing the robustness of the relationship between these anthropometric measures.

Similarly, Akhtar et al. conducted a study involving the measurement of head circumference and height in Garo adult females.[17] Their results exhibited a significant positive correlation coefficient of +0.278, a pattern akin to our study's outcomes. The convergence of these findings across diverse studies further underscores the reliability and consistency of the positive correlation observed between height and head circumference, emphasizing the broader applicability of this association in different populations.

Several researchers have tried to estimate height using measurements of long bones, and hand length and foot length. It is crucial to understand these variations among regions and races since each person's growth is impacted by a variety of circumstances, resulting in disparities in skeleton proportions. Also, a height estimate must be established based on the body parts known relationships to height when only a limited number of body parts are available.

One study has reported an association between a person hand print and stature. It was determined that it is feasible and trustworthy to estimate stature from handprint measurements.[24] Gul and Nizami have reported that ulna's length offers a trustworthy and generally accurate way to measure someone's height.[9] Prasad has reported strong association in all individual stature with head length and breadth.[25] One such study has estimated stature by using forearm length in male and female individuals.[26]

Kanchan R. et al. achieved success in formulating equations for stature estimation based on sixteen cephalo-facial measurements within the north Indian population.[13] Their study contributed valuable insights into the relationship between facial features and stature, offering a comprehensive approach to anthropometric estimations. Conversely, a recent investigation by Hiwarkar et al. delved into the correlation between body height and head and face dimensions within the Turkish population.[25] Contrary to the findings of Kanchan R. et al., Hiwarkar et al. concluded that the estimation of body height may not be reliably predicted through head and face dimensions alone. Importantly, it is noteworthy that the studies conducted by Kanchan R. et al. and Hiwarkar et al. exclusively focused on male populations, thereby lacking a comprehensive exploration of potential gender differences in the observed relationships. This highlights the need for further research to elucidate potential gender-specific variations in the correlation between cephalo-facial measurements and body height.

These collective insights underscore the versatility of anthropometric measurements in forensic and medico-legal contexts, offering valuable tools for stature estimation and identity determination. As the field continues to evolve, the integration of diverse anatomical measurements and consideration of population-specific factors remain essential for refining our understanding and application of anthropometric relationships.

CONCLUSIONS

In conclusion, our study establishes a noteworthy and statistically significant positive correlation between an individual's height and head circumference. This finding holds particular significance in the realm of Forensic Medico Legal cases, where precise identification is paramount. The observed relationship between height and head circumference can serve as a valuable biometric marker, aiding forensic investigators in establishing an individual's identity with increased accuracy. Moreover, anatomists and anthropologists stand to benefit from these insights, as the correlation provides a basis for refining anatomical and anthropological studies. The robust nature of the identified association underscores the potential practical applications of this research, contributing to both forensic science and anatomical disciplines.

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Author’s Contribution

S conceived the idea, and helped in the write up of the manuscript. UK, and NS designed the study, helped in collection of the data, and performed data analysis. AH performed data analysis, and helped in the write up of the manuscript. All authors made substantial intellectual contributions to the study.

Conflict of Interest

Authors declared no conflict of interest

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None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.