ORIGINAL RESEARCH REPORT

Does the Nias Tribe's Head Circumference Correlate with Body Height?

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ABSTRACT

Background: Anthropometric measures are one of the protocols frequently employed to identify deceased bodies. Height, age, and gender are a few anthropometric traits that might be utilized to identify the victim from the corpse. If body components are absent, head circumference can be used to determine body height. **Objective**: The goal of the study was to ascertain whether there is a correlation between head circumference and body height by gender and to create formulas for estimating weight based on head circumference in the Nias tribe at the University of HKBP Nommensen Medan, Indonesia. **Material and Method**: The study was conducted from September to October 2023 at the University of HKBP Nommensen using an observational cross-sectional design. Of the 100 students who met the inclusion criteria, 50 were men, and the remaining 50 were women. The study's dependent variable was micro-toise-measured height. The head circumference, expressed in meters of tape, served as the study variable. **Result**: *S*tatistical analysis of the study results from a significant correlation between the head circumference and the height ($r = 0.655$, $p<0.01$). The linear regression equation obtained was $y = 3200 x - 2.672$ in men and $y = 10970 + 2.728$ times in women, where y was height and x was head circumference. **Conclusion**: A substantial height-head circumference association was found among the Nias tribe at the University of HKBP Nommensen Medan, Indonesia. The identification method of the forensic field may benefit from this research.

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Highlights

1. A significant correlation was found between head circumference and height among Nias tribe students.
2. This study was conducted to obtain formulations for weight determination based on headbands in the Nias tribe.

BACKGROUND

Identification is an effort to support an investigator in fulfilling the visum et repertum requirement for a person's identification. As such, it can be helpful evidence in a criminal prosecution regarding a person's health, life, or body (Poluan, et al., 2016). Determining the identity of both the living and the dead, including those with the means to change their identity, such as murderers, criminals, rapists, parents who have switched babies, people undergoing cosmetic surgery to alter their appearance, and those suffering from memory loss requires identification in forensic medicine (Romdhon, 2015). In the event of a mass disaster, forensic identification can play a crucial role in assuring the victim's family of their identity and offering them psychological comfort (Saputri & Junitha, 2023).

In Indonesia, much information is shared regarding natural disasters that have caused significant damage, such as landslides, road accidents, tsunamis, and earthquakes. The Indonesian National Disaster Management Authority (BNPB) has published data indicating that there has been a rise in disasters in Indonesia so far in 2023, which has contributed to an increase in event charts over time (National Disaster Management Authority, 2022). The 9.3 magnitude retail scale tsunami that struck Aceh on December 26, 2004, is one of the natural disasters. More than 250,000 people lost their lives in an earthquake and massive tsunami that followed earlier. This incident is Indonesia's record for the highest tsunami ever recorded (National Disaster Management Authority, 2023). Another earthquake occurred in Yogyakarta 17 years ago, on May 27, 2006, with a force of 5.9 retail scale, which took thousands of lives (Putri & Kurniawan, 2022). Among these incidents, a common issue is difficulty in recognizing the victims' bodies when the limb damage is so severe that only a few body pieces remain (Imran, 2015).

Anthropometrics means measuring the human body, derived from the Latin word anthropos, which means human, and metron, which means measuring (Tur & Bibiloni, 2019). According to Sanders & McCormick, (1976) anthropometrics is the study of body dimensions that are important for the design of objects that other people use. Measurements of the body skeleton proportion that have been measured are made in an anthropometric order. Gender, race, origin, height, and other factors are also considered in the forensic science of human identity. The application of techniques for legitimate goals and scientific procedures both make use of forensic science. Some have suggested that because certain ethnicities differ in diet and climate, one forensic science of race's characteristics calls for its height measurement. Thus, additional research from every area must be taken into consideration. (Reddy, et al., 2018).

Anthropology does play a vital role in identifying humans. A critical parameter for identifying humans both in life and death is posture. One method used in estimating the body height of partial remains is, therefore, very useful in forensic science because of such disasters as suicide, tsunamis, earthquakes, wildfires, airplane accidents, and so on, is a technique used to approximate height by measuring specific body regions. The most visible posture is based on an excellent upright height and a definite biological link, as well as on each body part, such as the face, the head, the extremes, and the nose. Height estimates do not pose a problem if the body of the deceased is found intact. Anthropometric measures can help identify the body of the victim with a known identity or even an unknown identity and thus make it easier for investigators to search for the victim's identity (Prenetha & Babu, 2022).

The size of the spine, limb bones, neck, and skull are among the anthropological criteria for determining body height during identification. According to Shah, et al., (2017), research in India has demonstrated that head circumference can be used to estimate a person's height. A research by Larasati, et al., (2018) showed that head circumference has a robust correlation with body height in men of the Mongoloid race in Pandean, Surabaya. In another study by Bharti, et al., (2019), findings from a study on the Haryanvi people in the Panchkula area indicated a significant relationship between head circumference and body height. Research by Eboh & Ohaju-Obodo, (2019) defined a regression model for height estimates based on specific population characteristics and gender traits in particular populations and genders. According to the study's findings, a straightforward regression model incorporating medicolegal factors can assess a person's height based on their head circumference.

Indonesia is the most significant island nation in the world, with 17,508 islands. There are 360 different ethnic groups, each with unique cultural traditions and climates. Tropical conditions support a diverse range of terrestrial and marine life (Illahi, 2021). The statistical central body census collected

data showing more than 300 ethnicities and 1,340 Indonesian tribal groups as of 2010 (Graha, 2023). The province of North Sumatra is home to several different tribes, including the Nias, Javanese, Malay, and Batak. According to some estimates, there were 41.9% of the Batak tribe, 32.6% of the Javanese, and 6.3% of the Nias tribe. Based on data from the Civil Registry Service Office (*Dukcapil*), which registered around 890 thousand tribal individuals in North Sumatra in December 2021, the Nias is ranked as the third largest tribe in North Sumatra (Jayani, 2021). However, for the Nias tribe, specific anthropometric information is still scarce for forensic and identification purposes. This is urgent, given Indonesia's numerous natural disasters and criminal prosecutions. Thus, we aimed to investigate the correlation between body height and head circumference among the Nias tribe of North Sumatra.

OBJECTIVE

The study aimed to determine whether head circumference and gender-specific height were correlated and to develop formulas for determining headband-based height in Nias students at the University of HKBP Nommensen Medan.

MATERIAL AND METHOD

This study method was descriptive observational research using a sectional view design where the data collection occurs only once in a given moment. The study was conducted from September to October 2023 at the University of HKBP Nommensen using an observational cross-sectional design. Of the 100 students who met the inclusion criteria, 50 were men, and the remaining 50 were women. The study's inclusion requirements included being a current student at HKBP Nommensen University between the ages of 20 and 30, belonging to the Nias ethnic group, not having married into another ethnic group for at least two generations, and being willing to sign an informed consent form. In the meantime, having congenital deformities affecting the skull, trauma or dislocation affecting body height, having undergone or are undergoing a height-affecting dislocation, fracture, trauma, or injury; having previously undergone height-affecting surgical therapy; having a history of growth hormone imbalances or birth defects (such as dwarfism and acromegaly); and having a history of spinal abnormalities (lordosis, kyphosis, scoliosis) were the exclusion criteria for this investigation. The Health Research Ethics Community, Faculty of Medicine HKBP Nommensen University approved the study, with approval number 535/KEPK/FK/IX/2023 on 12 -09-2023.

In this study, head circumference was the dependent variable, and the body height was the independent variable. A microtoise was used to measure people's heights. The individual stands straight, with their arms hanging at their sides and their head aligned with the Frankfort Horizontal Plane (FHP). With the feet together and the body upright, measurements were taken from the vertex, or highest point on the head, to the heel. The measurer lines up the eye parallel to the height measuring rod and reads the measurement by glancing at the number printed on the microtoise. Following the decimal point, results were reported in centimetres to one digit. The measurement results were recorded in the questionnaire's height column under the respondent's identification information. Head circumference measurements were made while the participant was seated in the FHP plane at the level slightly above the glabella, or the midpoint between the brow ridges, to the opisthocranion perpendicular to the midsagittal plane. Pressing the tape on the hair requires hard pulling. The tape should not be allowed to slide past the head by using the middle finger on the side of the head. The ears were prevented from being inserted. Hairpins, clips, or similar objects would not be poked into the hair during the measurement. The measurement findings were recorded in the questionnaire's head circumference field. Both variables underwent three separate measurements, each performed by a trained individual. The average values were the measurement findings that were utilized. Every day, at the same time, between 08.00-09.00 am, measurements were taken until the necessary sample size was obtained.

The iPhone "Scoliometer" version 6.1 was used for scoliosis evaluation to rule out exclusion criteria. An examination was conducted to determine the Trunk Rotation Angle (ATR). The respondent must remove all clothing from the upper body during the scoliometer examination to fully view the ribs and spine. Wearing a sleeveless T-shirt and a head knot was necessary for ladies, but men can go bare-chested.

To evaluate the respondents, they had to bend forward until their shoulders were parallel to their hips. The respondents were instructed to stand with their knees straight, their feet parallel, and their hands hanging loose (Figure 1). The replies were then leans forward, feet together, knees straight, and hands either dangling freely (Safitri, et al., 2020). The cellphone's long side must be positioned at the top of the spine, above the spinous process, without being pressed, for the scoliometer program to work (Shaw, et al., 2012). Next, the curve degree numbers displayed on the software were read. Regarding early detection, values below 5° were deemed negligible and had little bearing on the outcomes of height measures (Nabila, 2020).

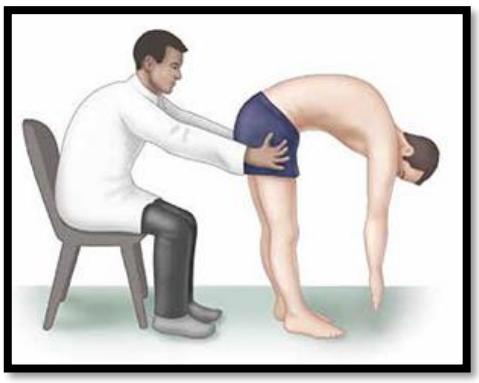

Figure 1. Forward bending position.

Kyphosis and lordosis assessments were carried out with the "Goniometer" iPhone app version 4.0.1. The phone's short side was positioned over the anatomical landmarks (T1–T3, T12, and L1) indicated on the spine for the goniometer software to function. The protractor was first set to 0°, and the phone was placed on the spinous processes of T1–T3. After that, the phone was positioned on the spinous processes of T12 and L1, and the angle shown on the screen was noted as the Thoracic Kyphosis Angle (TKA). The mobile's short side was positioned above the spine's anatomical markers (L1, L5) to measure the lordosis angle. The protractor was set to 0°, and the phone was positioned in L1's spinous process. Next, the cell phone was placed on the L5 spinous process, and the angle value displayed on the screen was recorded as Lumbar Lordosis Angle (LLA) (Elpeze, et al., 2023).

Data distribution was presented in a descriptive form with deviational standards and an average of normal data or a maximum distribution and value for the spread of abnormal data. Because the sample size was greater than 50, the data was examined using the Kolmogorov-Smirnov normality test on the entire data set. Next, a linearity test was performed to ascertain whether the data were appropriate for testing via a correlation test. The correlation test should be performed if there is a linear relationship between the two data sets; otherwise, it should not be employed. Positive linearity implies that as one variable's value rises, the value of another variable also increases. In contrast, negative linearity shows that when one variable's value rises, the value of the other variable falls. When testing for correlation, linear data will be put through the Pearson correlation test if the distribution of the two data is normal and the Spearman correlation test if not. In the p-value correlation test, a value of less than 0.05 indicates a significant correlation between the two variables under investigation. In contrast, a value greater than 0.05 indicates no considerable association (Dahlan, 2021). Scientists worldwide have employed the regression approach and the multiplication method extensively for this kind of computation, and they have all concluded that regression analysis offers the best estimates for stature reconstruction (Krishan, et al., 2010). Thus, linear regression analysis was applied to create a regression equation that may link this study's dependent and independent variables. Statistical analysis used IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA) and Microsoft Office Excel 2016.

RESULT

A sampling method was used to acquire samples from up to 100 individuals. According to Table 1, the distribution of sample characteristics based on the 21-year-old span was 67 people (67.0%), 23 people (23.0%) who were 22 years old, and 10 people (10.1%) who were 23 years old. Fifty males (50.0%) and fifty women (50.0%) comprised the gender distribution.

Table 1. Sample characteristics.

Variable	Category	Total	Percentage
Age	21	67	67.0%
	22	23	23.0%
	23	10	10.0%
Sex	Male	50	50.0%
	Female	50	50.0%

Table 2 shows the values of the two variables. The male sex's average height was 167.4 cm (SD=5.16), whereas the female sex's average height was 155.4 cm (SD=5.18). Male sex-related head circumference values were 54.15 cm (SD=1.46) and 52.97 cm (SD=1.87) for women. Descriptive statistics showed that the two variables were more significant in men than women. Table 2 reveals that p=0.000 indicates a significant association between the height of both sexes and head circumference. The head circumference and the height of the two sexes had a high positive link, as indicated by Pearson's Pearson correlation values of 0.908 and 0.986.

Table 2. Variable description based on gender.

Variable	Female			Male		
	Mean	SD	r (p-value)	Mean	SD	r (p-value)
Height	167.4	5.16	0.908 (0.000)	155.4	5.18	0.986 (0.000)
Head circumference	54.15	1.46		52.97	1.87	

Table 3 shows that regression analysis from a simple, linear analysis obtained the value of an independent variable constant of -2.609 and a 3.200 regression coefficient, with a value of p=0.000 (p< 0.05).

Table 3. Simple linear regression analysis.

Variable		Constant	Coefficient	Standard error of the estimate	p
Head circumference and height	Male	-2.672	3.200	2.1872	<0.001
	Female	10.970	2.728	0.8689	<0.001

Simple linear regression equations based on sex as follows:
1. On the male sample :
Y = (-2.672) + 3.200 X
Y = (-2.672) + 3.200 (head circumference)
Y = 3200 (head circumference) – 2.672

2. On the female sample:
Y = 10.970 + 2.728 X
Y = 10.970 + 2.728 (head circumference)

Description:
X = Head circumference
Y = Body height

DISCUSSION

The HKBP University Nommensen Medan is home to a diverse range of tribes because its students are from all parts of Indonesia. Approximately one hundred participants who satisfied the inclusion and exclusion criteria were included in the study. The measurements showed that the female form measured 155.4 cm, and the male figure was 167.4 cm on average. This was comparable to past studies on the Mongoloid race by Afandi, et al., (2021) when it was discovered that women had a flatbed measuring 156.2 cm and men had a flatbed measuring 167.3 cm. However, a notable finding from a study by Prenetha & Babu, (2022) at Saveetha Dental College on first-year students between the ages of 18 and 20 years old was that women's height was 158.62 cm and men's was 173.54 cm. Eboh & Ohaju-Obodo, (2019) study at six universities in southern Nigeria, students with Bekware, Esan, Kalabari, Ogbia, and Urhobo who were 18 to 30 years old obtained height in male 151 cm and female150 cm. This could be the case due to various factors influencing height growth, including nutrition, race, and environment.

The head circumference of the male was 54.15 cm larger than the woman's, measuring 52.97 cm, according to the findings of the univariant test of head circumference. This contrasts previous research on young Gujarati people between 18 and 22, which discovered that the female's head circumference measured 50.5 cm and the male's measured 55.6 cm (Bharti, et al., 2019). Additional research conducted in southern Nigeria yielded similar head-girl-line results of men measuring 52.1 cm and women measuring 54.1 cm (Eboh & Ohaju-Obodo, 2019).

A Pearson test for the line-ring correlation between the height of the body and the head circumference was the statistical outcome of this investigation. The head circumference and height had a high and substantial link, with a coefficient correlation of r =0.908 and a significant p-value of 0.000 for females and r=0.986 and a significant p-value of 0.000 for males. These findings in both the female and male groups demonstrated a very high association between head circumference and body height. This study correlated with a study conducted on the Mongoloid by Afandi, et al., (2021), which found a strong and substantial association between height and head circumference among the students of the University Medical School ($p<0.05$). According to a study by Febriawan, (2015), also on a Mongoloid race, there was a strong and significant correlation of $r = 0.61$ ($p<0.05$). The research conducted by Mansur et al. at Kathmandu University School of Medical Sciences in Dhulikhel, Nepal, from November 2011 to October 2012 revealed a strong correlation between height and head circumference. The correlation coefficients were 0.443 ($p < 0.01$) for males, 0.302 ($p < 0.01$) for females, and 0.398 ($p < 0.01$) for both genders combined. The regression equation for the relationship between height and head circumference was determined to be $Y = 1.734X + 70.36$ ($R2=0.196$) for males, $Y = 0.916X + 106.8$ ($R2= 0.091$) for females, and $Y = 1.648$ for the overall population (Mansur, et al., 2014). A study by Eboh & Ohaju-Obodo, (2019), conducted at six universities in southern Nigeria and involving students aged 18 to 30, has yielded a different conclusion from this study. Specifically, their association was modest, with $r=0.48$ ($p<0.05$). Additional research that supported Eboh & Ohaju-Obodo, (2019) findings was carried out at Saveetha Dental College on first-year students between the ages of 18 and 20, consisting of 35 males and 35 girls. The results showed a small relationship with $r = 0.45$ ($p=0.05$) (Prenetha & Babu, 2022).

Based on the information above, head circumference is among the best parameters discovered to have a strong and substantial link with an individual's height. Thus, in medical-legal investigations and anthropometry, if one of the two measurements, i.e., the person's height or head circumference, is known, the other can be calculated. A fundamental linear regression analysis was conducted on this study, yielding a significance value of 0.000. A value of <0.05 was considered significant.

Strength and limitations

The benefit of this research is that it provides a formula for calculating an individual's height using their head circumference measurements. Additionally, the study was conducted particularly for the Nias tribe, one of the ethnic groups that predominately resides in Medan. The research has a problem in that it does not categorize the Nias tribe according to their geographical areas of residency, which significantly impacts how the human body is shaped anatomically.

CONCLUSION

There was a significant correlation between head circumference and height. This research can help in the identification process in the forensic field.

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Conflict of Interest

According to the author(s), no conflict of interest exists.

Ethic Consideration

The Health Research Ethics Community, Faculty of Medicine HKBP Nommensen University approved the study, with approval number 535/KEPK/FK/IX/2023 on 12 -09-2023.

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Not applicable.

Author Contribution

WJL contributed to the conception, design, analysis, and interpretation of the data, obtaining funding, and administrative, technical, or logistical support. SVS contributed to the drafting of the article, critical revision of the article for important intellectual content, final approval of the article, provision of study materials or patients, statistical expertise, and obtaining funding. JPS contributed to obtaining funding, administrative, technical, or logistical support, and provision of study materials or patients.

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