Original Article

Body-Height Predictions with Lower Extremity Length in the Mentawai Ethnic Group

Rika Susanti, Taufik Hidayat, Citra Manela

Department of Forensic Medicine of Andalas University, Faculty of Medicine, Universitas Andalas, Padang, Indonesia

Abstract

Introduction: This study was aimed to determine the correlation between body-height with lower extremity length and to predict the formula for body-height prediction of the Mentawai ethnic group. **Material and Methods:** The research was conducted at several places on Sipora Island with a sample size of 201 persons and analyzed through a Spearman correlation test as well as simple and multiple linear regression analyses. **Results:** The simple linear equation for male upper leg was Y = 130.291 + 0.674 upper leg length (±7.496), female Y = 129.484 + 0.489 upper leg length (±4.522) and for male Lower leg was Y = 130.488 + 0.934 lower leg length (±4.520), female Y = 129.423 + 0.681 lower leg length (±3.590). The multiple linear regression equation for males was *Y* = 114.193 + 0.437 upper leg + 0.81 lower leg (±6.615*)* and for females was *Y* = 117.150 + 0.357 upper leg + 0.572 lower leg (±4.773). **Discussion and Conclusion:** The Mentawai ethnic adult aged male body height, upper leg length, and lower leg length were greater than in females. As well, there was a significant correlation between body height with upper leg length and lower leg length.The obtained regression equotions can be used in the future to predict Mentawai ethnic adult-aged male and female body-heigth.

Keywords: *Body height, lower leg length, mentawai ethnic group, regression analysis, upper leg length*

Introduction

The Mentawai are grouped into the Mongoloid Proto-Malays.[1-3] Geographically, the Mentawai Islands lie on the western side of Sumatra Island and are a disaster-prone region, specifically for tectonic earthquakes, tsunamis, coast abrasions, and landslides.[4] Unrecognized dead bodies often require identification from mass disasters, war, homicide, suicide, or accidents, and this is a very important component of the forensic examination. During a disaster victim identification operation, the anthropologic examination method is a secondary identification method used to recognize victims.[5-10]

One of the sources of data that must be utilized to identify an unrecognized victim's body is predictive bodyheight. Bodyheight prediction, specifically for a population of a certain region, is important when taking into account demographic differences.[8,11-14] This research's purpose was to establish a correlation between body-height with upper and lower leg lengths and to obtain a formula for adult-aged male and female body-height using upper and lower leg measurements with the Mentawai ethnic group.

Material and Methods

This research featured an analytical cross-section design. Sample acquisition was conducted in several villages on Sipora Island, Mentawai, in October 2016. The research subjects were adult male and female volunteers who agreed to be examined and fulfilled the inclusion and exclusion criteria. The sample was obtained through a consecutive sampling technique.

The inclusion criteria were respondents who were at least 20 years of age, Mentawai ethnicity, grew up on the Mentawai Islands, physically and mentally healthy, and willing to participate. The exclusion criteria were individuals with disease and genetic deformities of the bone. A sample size of 205 was reached, but in terms of the criteria, 201 persons were evaluated.

How to cite this article: Susanti R, Hidayat T, Manela C. Body-height predictions with lower extremity length in the Mentawai ethnic group. J Anat Soc India 2020;68:285-9.

Article Info

Received: 06 November 2019
Accepted: 21 November 2019
Available online: 28 February 2020

Address for corresponding:
Dr. Rika Susanti,
Faculty of Medicine,
University of Andalas,
Jalan Perintis Kemerdekaan No. 94, P.O. Box 49-25127,
Padang, Indonesia.
E-mail: rikasusanti1976@yahoo.com

Access this article online

Website: www.jasi.org.in
DOI: 10.4103/JASI.JASI_212_19
Quick Response Code:

The independent variables here were Mentawai ethnicity, gender, and age, and the dependent variables were body-height, upper leg length, and lower leg length.

Upper leg length is the length of the thigh, which is the distance from trochanterion to tibiale laterale [Figure 1a]. Lower leg length is the length of the tibia that is the length from the tibiale mediale to sphyrion [Figure 1b]. The participants' body-height, upper leg length, and lower leg length were measured according to an anthropometry method employing an anthropometry caliper tool [Figure 2a and b]. The data yielded were then analyzed with a Spearman correlation test. The conducted linear and multiple regression analysis determined the formula for body-height prediction from upper and lower leg length. Informed consent was granted by all participants. This research was approved by the Ethics Commission at the Faculty of Medicine, University of Andalas, Padang.

Results

Characteristics of the research subjects

This research was conducted with 201 subjects consisting of 73 males and 128 females. The general characteristics of the participants are presented in Table 1.

Body-height, upper leg length, and lower leg length of the research subjects

The measurements that were taken from the participants pertaining to body-height are listed in Table 2.

The upper leg measurements of the participants are shown in Table 3.

The lower leg length measurements from the participants are listed in Table 4.

Correlation analysis of research subjects' body-height with upper and lower leg length

To correlate the data, a data normality test was conducted and an abnormal distribution was obtained. The chosen correlation analysis was a Spearman nonparametric correlation.

From the Spearman correlation analysis, the participants' body-height with upper leg length was correlated and the results are presented in Table 5.

From the Spearman correlation analysis that was performed on the participants' body-height with lower leg length, the data yielded are listed in Table 6.

Simple linear regression analysis between research subjects' body-height with upper and lower leg length

All gathered data were then used for a simple linear regression analysis between male and female participants' body-height with upper and lower leg length. The formula used was:

$$Y = a + bx + SE$$

where Y was the dependent variable, in this case, body-height, a was a constant, b was the regression coefficient; x was the independent variable, specifically upper and lower leg length in cm, and SE was a standard error. From the analysis, the formulae of the simple linear regression equation to predict body-height based on the upper leg length were as follows:

a. For male individuals, the equation was:
   $Y = 130.291 + 0.674$ upper leg length (± 7.496)
b. For female individuals, the equation was:
   $Y = 129.484 + 0.489$ upper leg length (± 4.522).

From the analysis, the formulae of the simple linear regression equation to predict body-height based on lower leg length were as follows:

a. For male individuals, the equation was:
   $Y = 130.488 + 0.934$ lower leg length (± 4.520)
b. For female individuals, the equation was:
   $Y = 129.423 + 0.681$ lower leg length (± 3.590).

Multiple linear regression analysis of body-height with upper and lower leg length

Multiple linear regression analysis yielded the following results for upper and lower leg length of Mentawai male and female body-height:

a. For male individuals, the equation was:
   $Y = 114.193 + 0.437$ upper leg length $+ 0.81$ lower leg length (± 6.615)
b. For female individuals, the equation was:
   $Y = 117.150 + 0.357$ upper leg length $+ 0.572$ lower leg length (± 4.773).

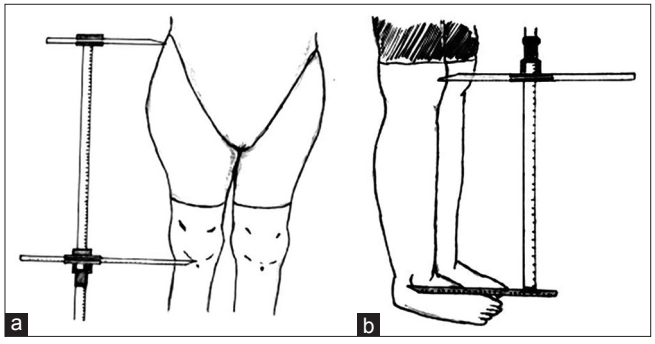

Figure 1: (a) Measurement of upper leg length and (b) measurement of lower leg length

Figure 2: (a) Measurement of lower leg length (b) measurement of upper leg length

Table 1: Characteristics of research subject

Data	Number of subjects, *n* (%)
Gender	
Male	73 (36.3)
Female	128 (63.7)
Age (years)	
≤20	7 (3.5)
21–30	65 (32.3)
31–40	52 (25.9)
41–50	38 (18.9)
51–60	23 (11.4)
≥61	16 (8.0)
Hair color	
Black	185 (92.0)
Black-white	13 (6.5)
White	3 (1.5)
Hair pattern	
Wavy	46 (22.9)
Curly	15 (7.5)
Straight	140 (69.7)
Skin color	
Fair yellow	71 (35.3)
Brown	130 (64.7)
Iris color	
Brown	164 (81.6)
Black	37 (18.4)

Table 2: Research subjects' body height

Gender	Subjects(*n*)	Body-height (cm)	Average (cm)	SD (cm)
Male	73	150.00–178.00	161.59	5.98
Female	128	136.00–170.00	150.94	5.63
Total	201	136.00–179.00	156.08	9.27

SD: Standard deviation

Table 3: Research subjects' upper leg length

Gender	Subjects(*n*)	Upper leg length (cm)	Average (cm)	SD (cm)
Male	73	36.30–55.00	46.46	3.95
Female	128	27.00–57.00	43.92	4.50
Total	201	25.00–57.00	40.07	6.71

SD: Standard deviation

Discussion

The race is an important factor in determining the correlation between a person's bone length with their body-height. Experts agree that there are three main racial groups in the world – Mongoloids, Caucasoids, and Negroids. Mongoloid races are from Middle Asia and East Asia, including archipelagos in Southeast Asia and America. Mongoloids are marked by several features, such as having short-to-small-tall figures, long and broad bodies, wide shoulders, and tight hips. They have short limbs, especially in the distal sections, small hands and feet with warped nails.[15,16]

The first human group that came to the Indonesian archipelago was known as the Proto-Malaya race. The Mentawai tribe is Proto-Malayans that originated from Yunan in approximately 2000 B.C. and arrived in Indonesia through Indochina by way of the Malaya Peninsula to Sumatra.[2] According to Marsden, the people in Nassau, Poggies, or Pagai Island are the same as those on the northern side of the island, such as the Sipora and Siberut Islands, being the Mentawai people. Mentawai body-height is seldom >5.5 feet. Their skin color is similar to the Malay, being fair brown or copper. It is believed the Mentawai ancestors originated from Siberut Island.[17]

It has been found that there is quite a significant difference between body-height and its correlation to the long bone length based on gender.[11-18] In the current work, the statistical analysis showed that Mentawai ethnic male's average body-height was higher than Mentawai females, on average of 11 cm more. This is in agreement with Indriati, Abrahamyan *et al*., Rahmawati *et al*., and Choi.[19-22]

A similar result was obtained from the comparison of upper and lower leg length between male and female participants. Here, Mentawai ethnic male participants' average upper leg length was 3 cm longer than female participants. Further, males had an average lower leg length that was 2 cm longer than females'. These differences are in line with the previous work of Abrahamyan *et al*.[21]

The Spearman correlation analysis demonstrated that the correlation coefficient for Mentawai male body-height with upper leg length was 0.405 while for female body-height and lower leg length was 0.407. The overall correlation coefficient between the body-height with upper leg length was 0.339. The Spearman correlation values of 0.405 and 0.407 indicate that the correlation was positive with a moderate correlation power, while the Spearman correlation value of 0.339 suggested that the correlation was positive with weak correlation power. Note that these values are different from the earlier work of Oliver, Choi *et al*., and Abrahamyan *et al*.[21-23]

The correlation analysis result of Mentawai male body-height with lower leg length produced a correlation coefficient value of 0.676, while for female body height with lower leg length, it was 0.509. The overall correlation coefficient between body-height with lower leg length was 0.400. The Spearman correlation value of 0.676 shows that the correlation was positive with strong correlation power and the Spearman correlation value of 0.400 indicated that the correlation was positive with moderate correlation power. A significance value (*P*) of 0.000 means that the correlation between body-height with upper and lower leg length was statistically significant. Those correlation coefficient differences most likely arose because of the participants and measurement methods used. Here, body-height, upper leg length, and lower leg length measurements were obtained with an anthropometry

Table 4: Research subjects' lower leg length

Gender	Subjects(*n*)	Lower leg length (cm)	Average (cm)	SD (cm)
Male	73	25.00–42.50	33.30	4.06
Female	128	25.00–41.00	31.61	3.91
Total	201	20.00–41.00	28.51	5.25

SD: Standard deviation

Table 5: Correlation of research subjects' body-height with upper leg length

Gender	Subjects(*n*)	Spearman correlation (*r*)	*P*
Male	73	0.405	0.000
Female	128	0.407	0.000
Total	201	0.339	0.000

Table 6: Correlation of research subjects' body-height with lower leg length

Gender	Subjects(*n*)	Spearman correlation (*r*)	*P*
Male	73	0.676	0.000
Female	128	0.509	0.000
Total	201	0.400	0.000

method employing an anthropometry caliper with agreed upon anatomical points.

Age was certainly a factor in this research. Here, the youngest participant was 20 years old and the oldest was 90 years old. The use of a broad age range also perhaps influenced the correlation coefficient. This is likely based on the increase of the role of factors other than upper and lower leg length that would influence body-height, such as, for example, the growth of vertebrae. Columna vertebralis still grow until 30 years of age and provides additional body-height growth of approximately 3–4 mm. In terms of research, this can cause bias because each group did not have the same characteristics.[24-26]

In this work, the researchers measured the percutaneous upper and lower leg length, which still has skin, muscles, and joints, so there could have been a roughly 2.5–4 cm difference with the formulae for body-height prediction from long bones in previous studies.

Based on the significant correlation between upper leg length and lower leg length with body height in an adult-aged group, regression analysis was conducted to obtain the equations for body-height prediction for Mentawai ethnic adult males and females. The simple and multiple linear regression equations here varied compared to those arrived at through earlier efforts as per the literature. These differences were thought to have occurred because of the differences in research subject characteristics, such as age, race, or gender. Moreover, the differences in the measurement method also impacted the obtained regression equations.

Overall, the importance of body-height determination is in circumstances where the remains of an individual are mutilated or just bones.

Conclusion

The Mentawai ethnic adult-aged male body-height, upper leg length, and lower leg length were greater than in females. As well, there was a significant correlation between body-height with upper leg length and lower leg length. The obtained regression equations can be used in the future to predict Mentawai ethnic adult-aged male and female body-height.

Acknowledgment

Researchers would like to thank to Indonesian Medical Association (IDI) of Mentawai Islands regency, Public Health Center (Pustu) Goiso'oinan's staff, and all those who have helped this research.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

PNBP fund of Faculty of Medicine of Universitas Andalas Padang.

Conflicts of interest

There are no conflicts of interest.

References

1. Jacob T. Studies on human variation in Indonesia. J Natl Med Assoc 1974;66:389-99.
2. Koentjaraningrat K. Human Being and Culture of Indonesia. Jakarta: Djambatan;1987:181.
3. Djakfar IH, Indra I. Revealing the prehistoric veil in Kerinci. Sungai Penuh: Kerinci Government. 2001:13-4.
4. Mulya SP, Suwarno Y. Mapping earthquake prone in Mentawai Island. J Ilmiah Geomatika 2013;19:106-12.
5. Lee JH, Kim YS, Lee UY, Park DK, Jeong YK, Lee NS, *et al*. Stature estimation from partial measurements and maximum length of lower limb bones in Koreans. Australian Journal of Forensic Sciences 2014;46:330-8.
6. Cerritelli A, Anderson R. New Interpol DVI Guide. Lyon; 2018:17.
7. Purwanti SH. From Bali's incident to Sukhoi's tragedy. Jakarta: Rayyana Komunikasindo;2013:77-111.
8. Blau S, Ubelaker DH. Handbook of Forensic Archaelogy and Anthropology. California: Left Coast Press;2009:237-40.
9. Budiyanto A, Widiatmaka W, Sudiono S. Forensic Identification. Jakarta : Forensic Medicine, Medical Faculty of University of Indonesia; 1997:200-02.
10. Bardale R. Principles of Forensic Medicine and Toxicology. New Delhi: Jaypee Brothers Medical Publishers; 2011:67.
11. Indriati E. Forensic Antropology : Identification of human skeleton, application of biologic antropology in law enforcement context. Yogyakarta: Gadjah Mada University Press; 2010:78-80.
12. Handajani PT, Prima A. Upper leg length as the determinant

of height in young adult men group. J Kedokteran Syiah Kuala 2014;14:38-42.
13. Burns KR. Forensic Anthropology Training Manual. New Jersey: Prentice-Hall.Inc.; 1999:154-57.
14. Comas J. Manual of Physical Anthropology. Springfield: Charles C Thomas Publisher; 1960:200.
15. Krogman WM. The human skeleton in forensic medicine. I. Postgrad Med 1955:153-68.
16. Jacob T. Forensic Anthropology on Biological Anthropology Book. Yogyakarta : Departmen of National Education of Indonesia; 2000.
17. Marsden W. History of Sumatra. Bantul: Indoliterasi; 1811.
18. Atmadja DS. Body-Height Predictions with Upper and Lower Extremity Length in Indonesian Population Group. Majalah Kedokteran Indones 1991;41:691-6.
19. Indriati E. Stature in Yogyakarta's student and prehistoric Balinese circa 1100 A.C. Berkala Ilmu Kedokteran 2002;34:1-7.
20. Rahmawati NT, Hastuti J, Ahizawa K. Age related variation on somatotypes of Javanese people in Yogyakarta Province. Berkala Ilmu Kedokteran 2008;40:181-8.
21. Abrahamyan DO, Gazarian A, Braillon PM. Estimation of stature and length of limb segments in children and adolescents from whole-body dual-energy X-ray absorptiometry scans. Pediatr Radiol 2008;38:311-5.
22. Choi BY, Chae YM, Chung IH, Kang HS. Correlation between the postmortem stature and the dried limb-bone lengths of Korean adult males. Yonsei Med J 1997;38:79-85.
23. Oliver G. Practical Anthropology. 1th ed. Springfield: Charles Thomas; 1969:23-9.
24. Sinclair D. Human Growth after Birth. 3rd ed. London: Oxford University Press; 1987.
25. Soekarto A. Segmental body growth change in female children from age of 7 until 10 years old in Yogyakarta. Berkala Ilmu Kedokteran 1980;12:41-7.
26. Adams BJ. Forensic Anthropology. New York: Chelsea house publisher; 2007:47-9.