

Predictive Body Height Model Based on Proximal Phalanx II Using X-Ray in Bataknese People

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Abstract

Background: Natural disasters or criminal acts that cause victims to die, in some cases the bodies of the victims can no longer be recognized because there has been severe damage such as only finding a few pieces of the body. Forensic identification of dead people or unidentified bodies, bodies in a state of damage due to rotting, burning, bomb explosions, land, sea and plane traffic accidents, tsunamis, earthquakes are very important and vital for further investigation.

Methods: This is a correlation analysis study on phalanx bone length and body height. A cross sectional study is conducted where data is collected only one time and in a specific time span. This study aims to correlate body height and proximal phalanx II bone in Bataknese people.

Conclusion: Based on the results, it is concluded that the TB, FP2R, and FP2L data are normally distributed, p -value $< 0,05$ ($p = 0,001$). There is a correlation (Sig FP2R = 0.200 ($p > 0,05$), with an intermediate correlation level between the right ($r = 0,353$) and left ($r = 0,400$) phalanx bone length in men and the right ($r = 0,464$) and left ($r = 0,479$) phalanx bone length in women of Bataknese people. It is concluded that proximal phalanx II has a correlation with body height with an intermediate correlation level ($r = 0,353- 0,479$), so proximal phalanx II is the best predictor for body height.

Keywords: body height, phalanx proximal II length

Introduction

From Various incidents like natural disasters, murder, terrorism, mutilation, and fire may leave body parts in an unidentifiable state, such as, damaged and cut corpse or only bones are left^{1,4,7,37}.

The province of North Sumatra is one of the regions that is susceptible to natural disasters, with

493 natural disasters with 2015-2016, flood itself comprised 299 of the 493 natural disasters. There are also a lot of accidents that happen in North Sumatra. On 18 June 2018, the accident of Sinar Bangun motorboat in Lake Toba, North Sumatra caused by overload of passengers, resulted in a high number of missing and dead people⁴.

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The identification process of natural disasters is similar to criminal suspect identification, which is the most important process of an investigation. Disaster victim identification must be done right to prevent a fatal mistake in an investigation⁵.

A study regarding body height estimation from phalanx bone has been done by Iyoti Agrawal et al from S.N. Medical College, Jodhpur, North India, which identify body height from the phalanx bone of university students and staff ranging from age 17-30¹⁴.

Until now, author has never found any study regarding body height estimation based on the proximal phalanx II bone based on radiographic info in Batakese people. Therefore, this study aims to examine the correlation between body height and proximal phalanx II bone in Batakese people.

Methodology

This is a correlation analysis study which aims to find the relationship between the phalanx bone and the body height. A cross sectional approach is used where data is retrieved only once in a specific time span. In doing so, the objective of this study is to examine the correlation between the proximal phalanx II bone and the body height in Batakese people. The study is done in Materna Hospital Medan, North Sumatra, from June 2024 until the minimal number of the study subjects is reached. There are 56 respondents according to the sample size calculated based on the sample size formula for numerical correlative analysis, with an estimate of the minimum correlation coefficient considered meaningful set at 0.4, which includes 37 women and 19 men within the age of 21-25. The inclusion criteria used in this study are: adult Batakese people, age 21-25, able to stand up without help from other people, willing to take part as a subject in this research by signing the informed consent, no history of fracture in right and left hand, no physical disability, and no congenital bone abnormality.

Meanwhile the exclusion criteria include: has history of hand and fingers fracture, unable to stand up without help from other people has physical disability, has history of surgical intervention for the bone of hand and finger, and has bone abnormality such as scoliosis, kyphosis, lordosis, and dwarfism.

Body height is measured with Wireless Body Height Meter from Onemed, product number HT-721, which measures up to 200cm and its accuracy is approximately $\pm 0,1$ cm, with a 35x16 cm LCD monitor, powered by 3 AAA battery, measures body height from the highest point (vertex) to the lowest point (heel/ floor) using ultrasonic from GEA. For body height measurement, respondents must stand upright without footwear, with 4 points (the back of the head, back, buttocks, and heels) pressed against the wall with the head facing straight forward. Wireless Body Height Meter is placed on top of the scalp, against the wall. While respondents move to the right and left, the button is pressed to measure the body height^{31, 36}.

The measurement of the proximal phalanx II is done after respondents submit the questionnaire, sign the agreement letter to be part of the study, and measure their body height. Respondents will then undergo X-Ray for both of their hand, which is then used to measure the length of the proximal phalanx II by drawing a line along the bone axis from the proximal to the distal point of the bone. The length of this line is measured in millimeter unit.

This research was carried out after obtaining ethical clearance approval from the Health Research Ethics Committee of the University of North Sumatra no. 731/KEPK/USU/2024.

Results and Discussion

The results of the descriptive analysis concerning age, height, length of the right and left proximal phalanx II based on male and female gender with the following results.

Table 1: Descriptive statistics

N =56	Categories	male	female
Age (years)	The Oldest	23	24
	The Youngest	22	21
	Mean	22,74	22,68
Height	The Oldest	180	167
	The Youngest	162	149
	Mean	172,29	159,10
FP2R (cm)	The Oldest	4,846	4,343
	The Youngest	3,758	3,545
	Mean	4,333	3,948

Continue.....

FP2L (cm)	The Oldest	4,864	4,490
	The Youngest	3,868	3,571
	Mean	4,346	3,988

Table 1 above illustrates the amount of data in the variables. The total respondents in this study were 56 respondents divided into 37 female respondents and 19 male respondents. The oldest age in the male respondent group was 23 years old, while the youngest was 22 years old. The average age in the male group was 22.74 years old. In the female respondent group, the oldest age was 24 years old and the youngest was 21 years old, and the average age in the female group was 22.68 years old. The highest height in the male respondent group was recorded at 180 cm, while the lowest was 162 cm. Meanwhile, the average height in the male group was 172.29 cm. Meanwhile, in the

female respondent group, the highest height was 167 cm, and the lowest was 149 cm. The average height in the female group was 159.1 cm. From table 1 above, it shows that for both height and length of the right and left proximal phalanx II bones at the same age, the male gender has a larger size.

QQ PLOTS Normality Test on Dependent Variables Height (TB), PF2R, FP2L

Based on the qq plot normality test image of the dependent and independent variable data, it was found that the data for the variables Height and right and left proximal phalanx II, most of the data distribution values are located around a straight line, so this shows that the dependent and independent variable data are normally distributed.

Pearson Correlation Test Result

Table 2: Correlation coefficient (level of relationship) of the Proximal Phalanx II bone with height

Gender	Variable	Correlation
Man	F2PR	0,353
	FP2L	0,400
	FP2R, FP2L	0,961
Woman	FP2R	0,464
	FP2L	0,479
	FP2R, FP2L	0,971
Male Female	FP2R	0,696
	FP2L	0,684
	FP2R, FP2L	0,976

In the male data set, the results of the Pearson correlation above show a correlation between height and the right and left proximal phalanx II bones in men, the correlations obtained are: FP2R with TB ($r = 0.353$), FP2L with TB ($r = 0.400$), FP2R, FP2L with TB ($r = 0.961$)

In the female data set, the results of the Pearson correlation above show a correlation between height and the right and left proximal phalanx II bones in women, the correlation obtained is: FP2R with TB ($r = 0.464$), FP2L with TB ($r = 0.479$), FP2R, FP2L with TB ($r = 0.971$).

In the male and female data sets, the results of the Pearson correlation above appear to show a correlation between height and the right and left proximal phalanx II bones, the correlations obtained are: FP2R with TB ($r = 0.696$), FP2L with TB ($r = 0.684$) and FP2R, FP2L with TB ($r = 0.976$). So it can be concluded that there is a statistically significant correlation between FP2R, FP2L with TB with a low to very strong correlation level.

Linear regression formula, the results of linear regression analysis produce 9 formulas with varying levels of accuracy.

Table 3. Height estimation formula from the right and left proximal phalanx II bones based on gender.

Sex	Variable		Correlation (r)	SEE
Man	FP2R	Height = 141,381 + 7,133 (FP2RM) ± 4,71	0,353	4,71
	FP2L	Height = 134,098+ 8.788 (FP2LM) ± 4,61	0,400	4,61
	FP2R, FP2L	Height = 132,41 - 8,262 (FP2RM) + 17,414 (FP2LM) ± 4,72	0,961	4,72
Woman	FP2R	Height = 121,323 + 9,586 (FP2RF) ± 4,29	0,464	4,29
	FP2L	Height = 123,205 + 8,999 (FP2LF) ± 4,25	0,479	4,25
	FP2R, FP2L	Height = 123,434 - 0,539 (FP2RF) + 9,475 (FP2LF) ± 4,31	0,971	4,31
Man /Woman	FP2R	Height = 88,025 + 18,523 (FP2RMF) ± 5,73	0,696	5,73
	FP2L	Height = 88,623 + 18,237(FP2LMF) ± 5,82	0,684	5,82
	FP2R, FP2L	Height = 87,656 + 15,926 (FP2RMF) + 2,667 (FP2LMF) ± 5,78	0,976	5,78

Description: FP2R: Right Proximal Phalanx II Bone Length ; FP2L: Left Proximal Phalanx II Bone Length ; FP2LR: Left and Right Proximal Phalanx II Bone Length; FP2RW: Right Proximal Phalanx II Bone Length Female; FP2RM: Right Proximal Phalanx II Bone Length Male; FP2LF: Left Proximal Phalanx II Bone Length Female, FP2LM: Left Proximal Phalanx II Bone Length Male; FP2RLM: Left and Right Proximal Phalanx II Bone Length Male; FP2RLF: Left

and Right Proximal Phalanx II Bone Length Female.

In this study, the lowest Standard Error Estimate was found at 4.25 (SEE=4.25) in the left proximal phalanx IIbone of Bataknese women. This shows that the accuracy in determining the height of the Bataknese people using the left proximal phalanx II bone of women is more accurate. Tabel 4.comparison of the results of this study with other studies

		Researcher	Jasuja (Etnis Jat Sikh)	Panjakash Karnataka Utara	Jaiswal (Etnis Karwar)	Actual height
MALE	left	173,2	195,2	154,7	194,4	175,3
	Right	172,1	192,3	150,0	189,4	
FEMALE	left	160,4	166,5	113,2	165,0	165,4
	Right	159,0	172,9	155,6	166,2	

From the table above, it can be seen that the regression results from our research are closer to the actual height value compared to the results of previous studies. In Jaiswal’s research on the Karwar ethnic group, the results for females were quite good, but for males, the results were too large from the actual height value. So it can be concluded that the formula we obtained can be recommended for estimating height from the length of the proximal phalanges for the Batak tribe in forensic identification cases that require height measurements.

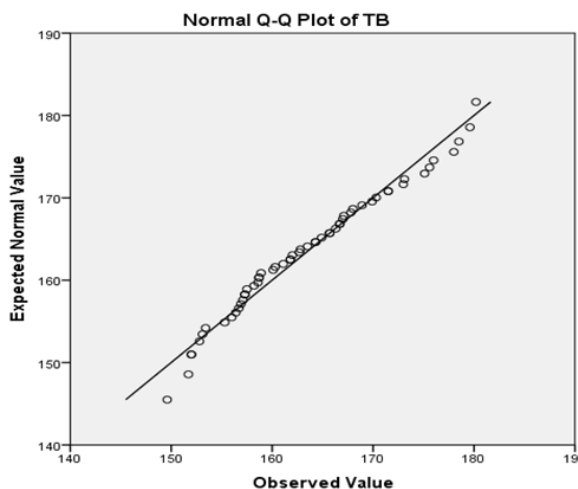


Figure 1: Q-Q PLOTS graph of height normality (TB)

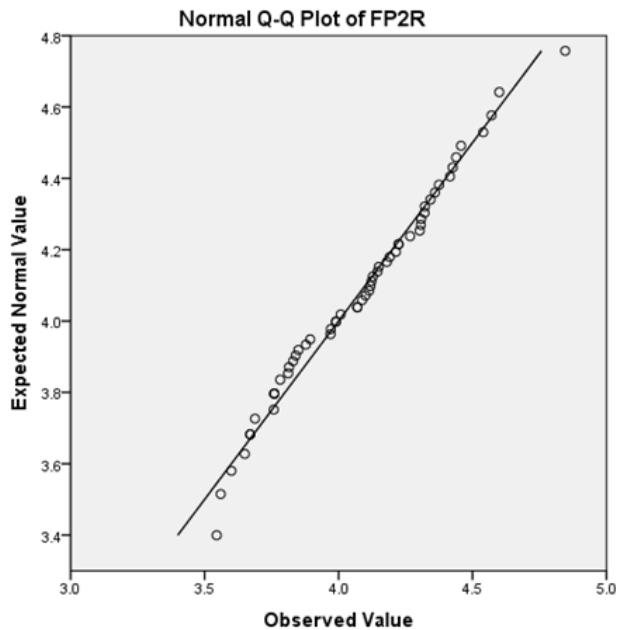


Figure 2: Q-Q PLOTS graph of the normality of the independent variable of the right proximal phalanx II (FP2R)

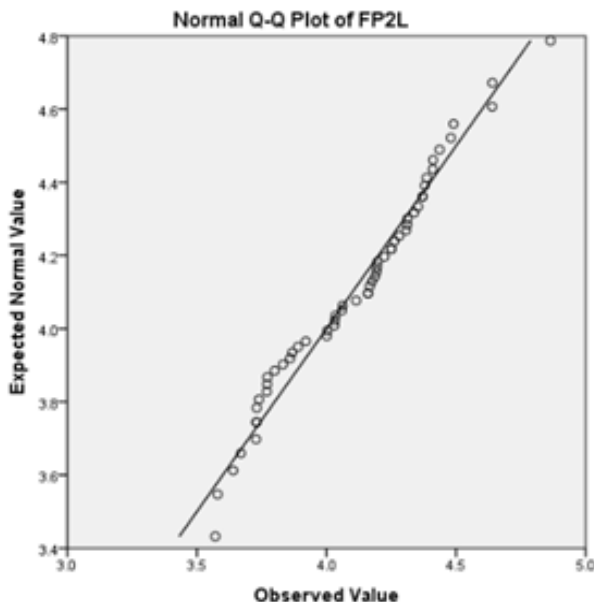


Figure 3: Q-Q PLOTS graph of normality of the independent variable of the left proximal phalanx II (FP2L)

Conclusion

From this study it was concluded that the proximal phalanx II has a relationship with height with a low to very strong correlation level ($r = 0.3 - 0.9$).

The influence of the proximal phalanx II on height is 7% to 48.4%, with the lowest Standard Error Estimate of 4.25 ($SEE = 4.25$) in the left proximal phalanx II of women. So that the left proximal phalanx 2 of women can be the best (most accurate) predictor in estimating height with the formula $TB = 123.205 + 8.999 (FP2LF) \pm 4.25$.

There are many variations in estimating stature from proximal phalanx bone measurements of people from different regions and races. so there is a need to do more research among people from different regions and ethnicities so that stature estimation becomes more reliable and individual identity is easy to determine

Conflict of interest: Estimasi of stature from any body remains especially proximal phalanges, which has an importance in forensic medicine in our country (Indonesia).

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