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Original Article

Determining Body Height Based on The Middle Finger Length (III digit of Manus)

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Abstract:

Introduction: Various kinds of events such as mass disasters or murder by mutilation can cause a person's limbs to be unrecognizable and even body parts to separate. Thus, estimating height is a major step in the process of identifying an unknown person. Research on the fingers is important to do to determine a person's identity because the pieces of bodies found are not always in the form of long bones; they can also be found in the form of short pieces such as fingers. Objectives: This study aims to determine the relationship between the length of the middle finger and the height of the members of the police force in the Medan-Sunggal sector in 2021. Methods: The design of this study was analytic correlation with a cross-sectional approach. The population of this study is male and female citizens aged 23 to 58 years who are members of the Sunggal Medan Police Sector in 2021 who meet the inclusion and exclusion criteria. The sampling technique used the total sampling method and amounted to 90 people. Results: The length of the middle finger has a positive and significant correlation with height, with a correlation coefficient ranging from 0.780 to 0.939 ($p<0.001$). The linear regression equation obtained shows the Standard Error of the Estimate (SEE) which ranges from 1.714 to 3.528 ($p<0.001$). Conclusion: There is a significant relationship between the length of the middle finger (digit III manus) and the height of the members of the Sunggal Medan Police in 2021 with a strong to very strong correlation coefficient, thus height can be estimated by measuring the length of the middle finger of the hand through the equation linear regression.

Keywords: Middle finger length, height, linear regression equation, Anthropometry.

1. INTRODUCTION

Various kinds of events can cause a person's limbs to be unrecognizable or parts of his body to be separated, such as mass disasters and accidents; murders, mutilations, to fires that can have an unidentified body, be damaged, or even charred so that its identity is not known.

Mass disasters can be caused by nature or humans and take many lives. Indonesia's natural conditions play an important role in disaster risk. Indonesia is located in the Southeast Asian archipelago consisting of 17,000 islands and 1.9 million km2 of land. The water area reaches 5.8 million with a coastline of more than 80,000 km. Indonesia is surrounded by the Pacific and Indian Oceans and is located between 2 continents, namely the Australian continent in the south and the Asian continent in the north. Geographically, Indonesia's position is flanked by 3 major world plates, namely the Indo-Australian Plate, the Eurasian Plate, and the Pacific Plate. This condition provides an indication that Indonesia is at high risk of experiencing natural disasters such as earthquakes, landslides, floods, tsunamis, as well as accidents on land, sea, and air. The National Disaster Management Agency (BNPB) recorded as many as 2,341 disaster events in 2017, with details of the 3 most common occurrences being floods (787), tornadoes (716), and landslides (614). The average disaster is influenced by weather and runoff. Data from the Meteorology, Climatology and Geophysics Agency (BMKG) during 2017 to December 20, 2017, revealed that there had been 6,893 earthquakes, of which 208 earthquakes with a magnitude of more than 5 on the Richter scale (SR). An earthquake in Lombok with a magnitude of 7.0 on the Richter Scale on August 5, 2020, was accompanied by hundreds of aftershocks after that. Meanwhile, of the 127 volcanoes in Indonesia, there are 2 volcanoes with the status of Caution and eruptions, namely Mount Sinabung and Mount Agung.

North Sumatra Province is one of the areas that are very at risk of natural disasters. This is evidenced by the number of natural disasters, as many as 493 incidents where floods dominated as many as 299 incidents from 2015 to 2016. Meanwhile, on June 18, 2020, the sinking of the Sinar Bangun Motor Ship (KM) in the waters of Lake Toba, North Sumatra caused by excess passenger capacity resulted in many victims missing and dying.

In addition to the above incident, another case that allows the victim's body to be cut into several pieces is murder by mutilation. Generally, the killer aims to eliminate his traces and the identity of the victim. The main problem that complicates the identification process is when the victim's body is cut into small pieces and it is very difficult if only a visual examination is carried out, so forensic identification will be required. Mutilation cases recorded by the Police Public Relations in 2011 occurred in as many as 12 cases and increased in 2012 to 18 cases. In 2016, cases of murder accompanied by mutilation increased by 16.41% or to 78 cases, which in the previous year amounted to 67 cases. In a 2017 study of criminal statistics by the Central Statistics Agency, it was revealed that in the last five years the number of incidents of crimes against life in Indonesia has tended to fluctuate. North Sumatra Province was recorded as the province with the largest number of

crimes against life, namely 161 incidents in 2016 with more than 100 murder cases. Due to the various cases that have occurred and the development of science, there are many studies regarding the estimation of height based on certain bone lengths. Basically, every human being has a different body shape. There is also a difference between the length of one body part and another. This is because each part of the body is unique and has its own possibility of defining a biological correlation. The existence of this difference can be used in determining a person's identity. Determination of a person's identity can be done on people who are still alive or dead. Forensic anthropometry plays an important role in formulating a biological profile that involves determining height, sex, ethnicity and nationality and age so that it can provide a simple identification of a person.

Height as one of the important anthropometric parameters. In general, height plays a role in determining Body Mass Index (BMI), nutritional status, basal energy requirements, testing stages in the acceptance of Human Resources (HR) such as the Police, even for medicolegal purposes.

Estimation of height is also a major step in the process of identifying an unknown person, especially when there has been a mass disaster or murder by mutilation and only parts of it have been found. Thus, the estimation of a person's height becomes an indispensable parameter in anthropological studies and forensic identification.

Height estimation can be done based on other body parts, such as the following bones, namely humerus, radius, ulna, femur, tibia, fibula, phalange, sternum, nose height, calcaneus, and footprints. Several studies regarding the estimated height have been conducted at the Faculty of Medicine, University of North Sumatra, namely the metacarpal bone, ulna bone, and tibia bone.

Many studies have been carried out on estimating height based on long bones, but this is not the case with short bones, which is still rarely done in Indonesia. While abroad, research on the measurement of short bones such as those on the fingers is not uncommon. This research on the fingers is important to do to determine a person's identity because pieces of bodies found, such as in medicolegal cases or disaster events, are not always in the form of long bones, and can also be found. in the form of short pieces like fingers.

Based on the results of research conducted by Fatati (2013) regarding the correlation between height and finger length, it was found that there was a significant relationship between height and the length of 3 fingers, namely the index finger, middle finger, and ring finger with the strongest relationship strength. on the middle finger. Likewise with the research conducted by Putri (2017) on the correlation of the length of the index finger (digiti II manus) to the height of adult men from the Balinese and Batak tribes in Tanjung Glad Bandar Lampung District with a total sample of 35 men aged 21-45 years. Who gets the results of a moderate correlation between the length of the index finger bone and height.

In India, a study was conducted on finger length against height and the results obtained a stronger correlation in men than women. This is similar to the study of the middle finger as a

determinant of height conducted in the Indian population with a sample of 500 students aged 20-30 years and the results were male height was more significant than female. Meanwhile, the only research on middle finger length on height in Indonesia was conducted by Mirza (2013) who found a relationship between middle finger length and height.

However, there are differences in the average height in each of the previous studies. This is because height is influenced by the interaction of genetic factors (genes) and environmental factors. According to the Hardy-Weinberg law of equilibrium, height is passed down continuously from generation to generation. Genetic factors that come from parents are permanent through the father's lineage with biological children and affect the ethnicity of an individual. This causes ethnicity to be included in factors that affect height.

Indonesia has various ethnic groups, one of which is the Batak tribe with the third largest population after the Javanese, and Sundanese at 3.58% with the main area located in North Sumatra Province. There are eight ethnic groups or indigenous ethnic groups that mingle inhabiting the province of North Sumatra plus the presence of immigrant tribes such as Javanese, Minang, Acehnese, including Indian and Chinese ethnicities. Nevertheless, the Batak tribe, which consists of six sub-tribes such as Toba, Mandailing, Karo, Simalungun, Pak-pak, and Angkola Sipirok, is the largest tribe that occupies the area of North Sumatra, which is 44.75%. In addition to race factors, age also affects height growth, especially in bone classification. Height growth that peaks in adolescence, which is around 12-16 years, then slows down at the age of about 18-20 years due to the union of the epiphyseal plate. The center of calcification at the ends of the bones or the so-called "Epiphyseal Line" will end with age and the fusion of the plates on average until the age of 21 years in each bone.

Bone growth that still continues under the age of 21 will cause a bias if research is carried out at that age. Until now, research on the relationship between middle finger length and height in Indonesia has still been rarely done. Thus, researchers are interested in conducting research on determining height based on the length of the middle finger (digit III manus) in the residents of

Citra Wahana Pancur Batu Deli Serdang housing estate. Based on the above background, the formulation of the research problem is whether there is a relationship between the length of the middle finger (digit III of the manus) and the height of the residents of Citra Wahana Pancur Batu Residence, Deli Serdang.

2. MATERIAL AND METHOD

The design of this study was analytic correlation with a cross-sectional approach. The population of this study is male and female citizens aged 23 to 58 years who are members of the Sunggal Medan Police Sector in 2021 who meet the inclusion and exclusion criteria. The sampling technique used the total sampling method and amounted to 90 people.

3. RESULT AND DISCUSSION

Results and discussion The research was conducted from July 16 to July 22, 2020, at the Citra Wahana Pancur Batu Residence, Deli Serdang. The data obtained was then collected and processed through the editing, coding, entry, cleaning, and saving processes. Furthermore, the data were analyzed in two stages; the first stage was univariate analysis to produce the distribution of frequency, percentage and average value of the dependent and independent variables. The second stage is bivariate analysis to determine the relationship between the two variables.

Univariate Analysis

Gender Frequency Distribution

Table 1 Frequency distribution of Gender

Gender	Frequency	Percentage(%)
Male	21	33,3
Female	42	66,7
Total	63	100

Based on the table above, the sample frequency was 21 people (33.3%) and 42 people (66.7%).

Age frequency distribution

Table 2 Age frequency distribution

Age	Frequency	Percentage (%)
21-25	50	79,4
26-30	6	9,5
31-35	2	3,2
36-40	2	3,2
41-45	3	4,8
Total	63	100

Based on the table above, the frequency of samples aged 21-25 years was 50 people (79.4%), aged 26-30 years, were 6 people (9.5%), aged 31-35 years, as many as 2 people (3.2%), aged 36-40 years, as many as 2 people (3.2%) and aged 41-45 years, as many as 3 people (4.8%).

The results of the measurement of the middle finger of the right hand

Table 3 Measurement results of the middle finger of the right hand

Gender	Average (standard deviation)
Male	7.508 (0.362)
Female	6.889 (0.304)
Total	7.096 (0.435)

Table 3 shows that the average length of the middle finger of the right hand for men is 7.508 cm; the average length of the middle finger of the right hand for women is 6.889 cm, while the average length of the middle finger of the right hand as a whole is 7.096 cm.

Left hand middle finger measurement

Table 4 The results of the measurement of the middle finger of the left hand

Gender	Average (standard deviation)
Male	7,592 (0,430)
Female	6,854 (0,381)
Keseluruhan	7,100 (0,528)

Table 4 shows that the average length of the middle finger of the left hand for men is 7.592 cm; the average length of the middle finger of the left hand for women is 6.854 cm; while the average length of the middle finger of the left hand as a whole is 7,100 cm.

Height measurement results

Table 5 Height measurement results

Gender	Average (standard deviation)
Male	166,079 (5,519)
Female	155,070 (3,804)
Total	158,860 (6,823)

Table 5 shows that the average male height is 166.079 cm; the female average height is 155.070 cm, while the overall average is 158.860 cm.

Bivariate Analysis

Normality test

Normality test of the measurement results needs to be done first to determine the correlation test to be used. The normality test between numerical and numerical variables consists of the Kolmogorov-Smirnov test, which is recommended for large samples (more than 50) and the Shapiro-Wilk test for small samples (less or equal to 50). The normality test will produce a P-value that can determine the distribution of normal or abnormal data. A variable that has a P-value>0.05 means that the data distribution is normal, on the other hand if the P value <0.05 then the data distribution is not normal. The results of the normality test for each variable are as follows:

Table 6. Normality test results

Gender	Variable	Kolmogorov Smirnov P
Male	Right hand middle finger	0,200
	Left hand middle finger	0,200
	Height	0,200
Female	Right hand middle finger	0,200
	Left hand middle finger	0,064
	Height	0,200
Total	Right hand middle finger	0,200
	Left hand middle finger	0,200
	Height	0,011

Based on table 4.6, there is only one variable that is not normally distributed, namely overall height with a value of P=0.011 (P<0.05), while the other variables are normally distributed.

Linearity test

Linearity test is used to determine whether a data can be tested by correlation test. The relationship between two linear data can be tested with a correlation test, while those that are non-linear are not tested for correlation. The linearity assumption is checked by making a scatter graph. According to the statistical book by Sopiyudin (2014), the distribution of data has a linear impression if a relationship follows a straight line pattern that can be seen through the scatter graph. Linear can be linear with a positive direction and a negative direction. Positive linear means that the greater the value of a variable, the greater the value of the other variables. In contrast to negative linear, that is, the higher the value of a variable, the lower the value.

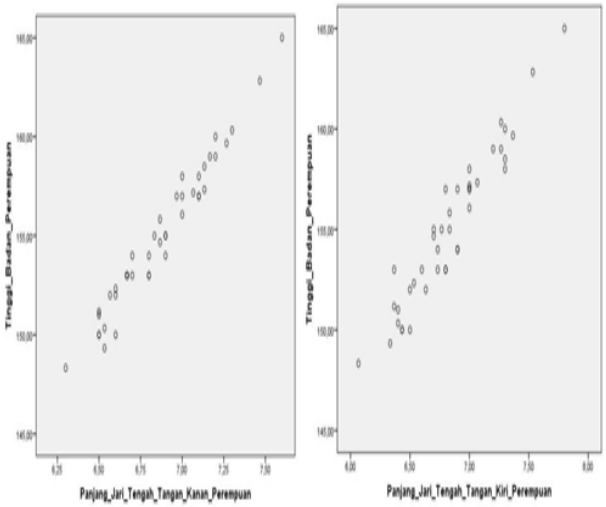

Figure 4.1 shows a scatter graph between the height and middle finger of a male

hand. The relationship between height and the middle finger of a man's right hand has the impression of a positive linear relationship, and the relationship between height and the middle finger of a man's left hand also has the impression of a positive linear relationship.

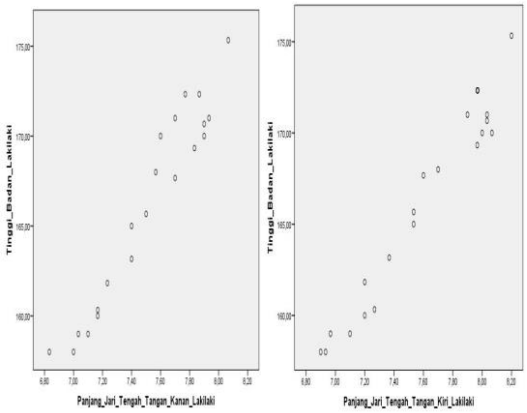

Figure 4.2 Scatter graph between height and middle finger of a woman's hand

Figure 4.2 shows a scatter graph between the height and middle finger of a woman's hand. The relationship between height and the middle finger of a woman's right hand has the impression of a positive linear relationship, and the relationship between height and the middle finger of a woman's left hand also has the impression of a positive linear relationship.

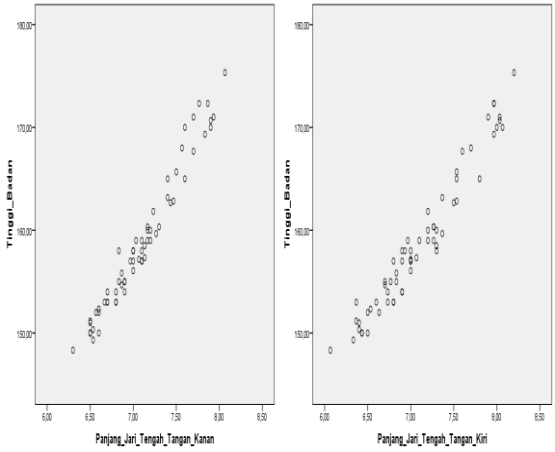

Figure 4.3 shows a scatter graph between the overall height and middle finger of the hand.

The relationship between height and the middle finger of the right hand has the impression of a positive linear relationship, and the relationship between height and the middle finger of the left hand also has the impression of a positive linear relationship.

Correlation test

The correlation test between numeric and numerical variables, one of which is normally distributed, is the Pearson test, while the correlation between numeric and numeric variables that are not normally distributed is using the Spearman test. After the normality test and linearity test, the correlation test that can be used in this study is the Pearson test because one of the variables is normally distributed and the linearity requirements are met.

The things that are included in the interpretation of the correlation test are statistical correlation strength, direction of correlation, p-value, and clinical significance. On the strength of the correlation, values 0.0-0.05, it means that there is no correlation between the two variables. And for clinical significance, if obtained r is minimal (0.00) it means that the correlation between variables is significant.

Table 7 The relationship between the length of the middle finger of the right hand and height

Gender	Total	Pearson correlation (r)	P
Male	21	0,866	<0,001
Female	42	0,902	<0,001
Total	63	0,939	<0,001

Table 7 shows that the relationship between the length of the middle finger of the right hand and height in men has a correlation coefficient of 0.866 (p < 0.001), the direction of the correlation is positive (+), and > r is minimal. The relationship between the length of the middle finger of the right hand and height in women has a correlation coefficient of 0.902 (p < 0.001), the direction of the correlation is positive (+), and > r is minimal. The relationship between the length of the middle finger of the right hand and overall height has a correlation coefficient of 0.939 (p<0.001), the direction of the correlation is positive (+), and >r is minimal.

Table 8 The relationship between the length of the middle finger of the left hand and height

Gender	Total	Pearson Correlation ®	P
Male	21	0,784	<0,001
Female	42	0,780	<0,001
Total	63	0,858	<0,001

Table 8 shows that the relationship between the length of the middle finger of the left hand and height in men has a correlation coefficient of 0.784 (p < 0.001), the direction of the correlation is positive (+), and > r is minimal. The relationship between the length of the middle finger of the left hand and height in women has a correlation coefficient of 0.780 (p < 0.001), the direction of the correlation is positive (+), and > r is minimal. The relationship between the length of the middle finger of the left hand and overall height has a correlation coefficient of 0.858 (p<0.001), the direction of the correlation is positive (+), and the minimum >r is obtained.

Linear regression analysis

Next is the estimation of height from the length of the middle finger of the hand obtained through linear regression analysis. The regression analysis will produce an equation that can relate the dependent variable to the independent variable. Linear regression is used if the independent variable is a numeric variable. Variables that can be included in linear regression analysis are variables which in the correlative test have a p value <0.05. All results of the correlative test have a value of p < 0.001 (p < 0.05) so that all data can be analyzed using linear regression.

Based on the results of the linear regression analysis in Table 9, a linear regression equation can be formulated based on:

y= a+ bx

Information:

Y = Dependent Variable a = Constant

b = Coefficient of independent variable

x = Independent variable

so that the relationship between the length of the middle finger and height is obtained through a linear regression equation as follows:

1. In the male sample

a. Male height (cm) = 58.135 + 14,481 x length of right hand middle finger (cm)

b. Male height (cm) = 79.497 + 11.276 x the length of the middle finger of the left hand (cm)

2. In the female sample

a. Female height (cm) = 68,620 + 12,590 x length of right hand middle finger (cm)

b. Female height (cm) = 97,261 + 8,478 x the length of the middle finger of the left hand (cm)

3. On the whole sample

a. Height (cm) = 45.854 + 15.985 x length of right hand middle finger (cm)

b. Height (cm) = 65,438 + 13,318 x the length of the middle finger of the left hand (cm).

4. DISCUSSION

The sample in this study consisted of 21 men and 42 women. The number of samples of women is more than men because in this population the number of women is more dominant than men. The most age group in this research sample is 21-35 years old because 21 year old residents, especially 35 year old residents, currently dominate the population of Citra Wahana Pancur Batu Deli Serdang Residential Residents. In addition, the inclusion criteria of this study were residents of Citra Wahana Pancur Batu Housing, Deli Serdang Regency, starting from the age of 21 years to 45 years.

From the results of the study, it was found that the average length of the middle finger of the right and left hands in men was longer than women. It was also found that the average height of men was higher than that of women. This is in accordance with research conducted on medical students at Syiah Kuala University, medical students in the class of 2013 at Sam Ratulangi University, the Indian population in Manipal, the Nigerian population, and a 2017 study on medical students at the Muhammadiyah University of North Sumatra.

The difference in average height between men and women is caused by the different growth rates between men and women. Around the age of 10, the rate of growth for boys and girls tends to be the same. However, after the age of 12, the growth rate of boys tends to be faster than that of girls, this causes most boys who reach adolescence to be higher than girls. This gender difference is also related to the age of puberty, where the age of puberty in boys occurs two years later than in girls so that they have a longer time to grow. So in theory it is stated that adult men are taller, have longer and heavier legs, and larger and denser muscle mass than adult women.

The male sample in this study had an average size of the middle finger of the left hand which was longer than the middle finger of the right hand, in contrast to the results in the female sample who had an average size of the middle finger of the right hand which was longer than the middle finger of the hand. left. The results of this measurement are in accordance with a study conducted on medical students at Syiah Kuala University and the Indian population in Manipal.

There was no significant difference in the average length of the middle finger of the right and left hands for both men and women in this study. As for anthropometric studies, it is found that the portion of the measurements obtained from the right side is indeed different from the left side. This right and left difference in individuals is called asymmetry. Asymmetric extremities may occur spontaneously and are not associated with musculoskeletal pathology. Generally, the upper extremities display a greater degree of asymmetry than the lower extremities.

The relationship between the length of the middle finger and height has a strong (0.780-0.784) to very strong (0.858-0.939) correlation. These results are in accordance with research conducted on the Indian population in Manipal, but different from research conducted at Airlangga University, where in this study a moderate correlation was found between the length of the middle finger of the hand and height. Meanwhile, research conducted at Syiah Kuala University has a moderate to strong correlation for men and women. The length of the middle finger of the hand shows an accurate correlation coefficient value indicating that the length of the middle finger of the hand has a significant relationship with height so that it can be used as a source of measuring tools for estimating height. Previous research has also shown that middle finger length is the most accurate measurement for estimating height than other finger lengths.

Estimation of height can be done by finding a special regression. This study has found a linear regression equation that can be used to estimate height from the length of the middle finger of the hand. The equation has a Standard Error of the Estimate (SEE) which ranges from 1.714 to 3.528. SEE is a good parameter in terms of showing the relationship between the original value and the estimated value. The accuracy of the linear regression equation is indicated by the smaller the SEE value. The female sample has the lowest SEE value (1.714-2.465), this indicates that the linear regression equation in the female sample shows more accurate results. These results are in agreement with studies conducted on the Indian population at Manipal and Syiah Kuala University.

The difference in the proportion of the body between one population and another is influenced by various factors. These factors are internal factors such as genetic, ethnic, racial, and gender factors, as well as external factors that include the environment, nutrition, socio-economic, and physical activity. This causes the linear regression equation for one population may not be used in other populations, and therefore, different linear regression equations must be found in each population to provide the most accurate results.

5. CONCLUSION

From the results of the study, it was found that there was a significant relationship between the length of the middle finger (digiti III manus) to the height of the residents of the Pancur Deli Serdang Wahana Stone Wahana Housing accompanied the middle of the hand through the linear regression equation as follows:

1. Male height and length of the middle finger:

a) Male height (cm) = 58,135 + 14,481 x Length of the middle of the middle of the right hand (cm)

b) Male height (cm) = 79,497 + 11,276 x Left Hand middle finger length (cm)

2. Women's height and length of the middle finger:

a) Women's height (cm) = 68,620 + 12,590 x Length of the middle of the right hand (cm)

b) Women's height (cm) = 97,261 + 8,478 x Length of the middle of the middle hand (cm)

3. Height of the overall body and length of the middle finger:

a) Height (cm) = 45,854 + 15,985 x Length of the middle of the right hand (cm)

b) Height (cm) = 65,438 + 13,318 x Length of the middle finger of the left hand (cm)

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