



Relationship Between Body Height with Upper Arm Length, Sole Length and Foot Width in the East Jakarta Region

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Abstract. Height or stature is one of the four main parameters used to identify individuals, along with sex, age, and ethnicity. In cases where a body has been fragmented or dismembered, estimating a person's height by measuring long bones can help determine his identity. Research on the relationship between height and upper arm or leg length has not been widely conducted in East Jakarta, thus important to gather primary data on this topic within this community. Therefore, this study aims to investigate the relationship between height and upper arm length, foot length, and foot width in a sample of 124 individuals from the East Jakarta region, using a descriptive analytic research method. The results of the study indicate a strong correlation between height and the length of the right upper arm (0.930) and left upper arm (0.932), the length of the right foot (0.893) and left foot (0.897), and the width of the right foot (0.743) and left foot (0.750). These findings suggest that there is a significant association between height and upper arm length, foot length, and foot width.

Keywords: Correlation, East Jakarta, Upper arm length, Foot length and width, Height.

1 Introduction

Height or stature is one of the four main parameters used to identify individuals, along with sex, age, and ethnicity [1]. In cases where a body has been fragmented or dismembered, estimating a person's height by measuring long bones can help determine his identity [2].

The upper and lower extremities consist of long bones, such as humerus, ulna, radius, femur, tibia, and fibula. Long bones have a high correlation with a person's height [3]. The soles of the feet are part of the long bones that have a positive correlation with height [4]. As research that has been conducted on ethnic Turkish students at Karadeniz Technical University (KTU) shows a strong correlation between upper extremity components and height [5]. A separate study also found a significant correlation between leg length and height in males and females students at the Faculty of Medicine, Sam Ratulangi University Manado [4].

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DKI Jakarta Province has a diverse range of ethnic groups residing in Jakarta. The Javanese ethnicity holds a dominant position within the DKI Jakarta Province [6]. Moreover, research on the relationship between height and upper arm or leg length has not been widely conducted in the city of Jakarta [7], especially in the East Jakarta area. To date, research on the relationship between height and long bones has only been conducted on students with primary data and communities with secondary data in the city of Jakarta. Therefore, it is necessary to conduct research in the community with primary data on the relationship between height and upper arm length, sole length, and foot width as a comprehensive stature identification approach, especially in the population in East Jakarta. Analyzing the effect of sex, physical activity, and level of milk consumption on height in the population in East Jakarta is also important for supporting data.

2 Materials and Method

2.1 Subject

The methods of this study has been approved by Health Research Ethics Committee of the Faculty of Medicine, University of Lampung No.786/UN26.18/PP.05.02.00/2023 to measure height, upper arm length, sole length, and foot width. This study was conducted in 10 sub-districts of East Jakarta City with a total of 124 subjects consisting of 52 males and 72 females. The study was conducted from January until March 2023.

The subjects were people living in the East Jakarta Region age range of 20 until 30 years. This age range was chosen because individuals generally reach their maximum height at around 20 years old [8], and after the age of 30, height declines by 1 mm per year [9]. Only participants who were willing to participate in the study by signing the informed consent form will be involved as research subjects. The study exclude individuals with a prior history of upper limb and leg abnormalities, fractures in the limbs, and spinal deformities such as scoliosis, kyphosis, and lordosis. Demographic data including sex, age, ethnicity, milk consumption levels, physical activity, parental education, and parental income will be collected as supporting variables for analysis.

2.2 Measurements

Anthropometric measurements include upper arm length, sole length, foot width and height. The measurement results are shown in cm (centimeters). All measurements were taken on the right and left side with two times measurements on each side. The average from two measurements was used for further analysis.



Fig. 1. Upper arm length measurement (Source: Personal documentation)

Upper arm length: The measurements were taken using a vernier caliper ranging from 0-600 mm in size. The respondents were positioned in a standing upright stance with their elbows bent at a 90-degree angle and measured from the highest point on their shoulder to the point where the elbow creases (Fig. 1).



Fig. 2. Measurements sole length (Source: Personal documentation)

Sole length: The measurements were taken using a vernier caliper ranging from 0-600 mm, taking the distance from the heel to the tip of the longest toe (Fig. 2).

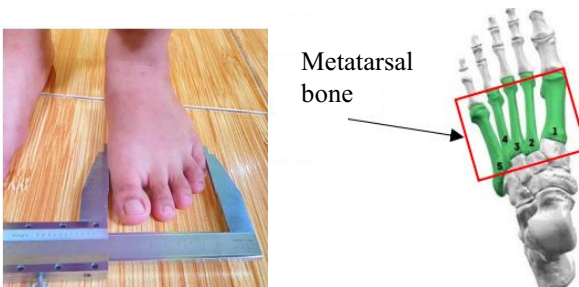


Fig. 3. Measurements foot width (Source: Personal documentation; geekymedics.com)

Foot width: The measurements were taken using a vernier caliper ranging from 0-600 mm, measuring from metatarsal 1 to metatarsal 5 (Fig. 3).



Fig. 4. Height measurement. (a) using microtoise; (b) using wireless body height meter (Source: Personal documentation)

Height: Height measurements were collected for participants in a standing upright position using a microtoise or wireless body height meter. Height was measured from the tip of the heel to the top of the head. As the microtoise method, the tool was mounted on the wall and pulled to the top of the participant's head. As the wireless body height meter, the tool was placed on top of the participant's head then the participant's steps aside and the button was pressed to obtain measurements.

Data were analyzed using the Spearman correlation test to see the relationship between height with upper arm length, sole length and foot width. Furthermore, the data were analyzed using linear analysis model to see the effect of sex, physical activity, milk consumption level, and parental education on the variable of height. The program that was used to analyzing the data is the R 4.2.3 program.

3 Results and Discussion

The average height, upper arm length, sole length, and foot width on males were greater than those of females. This finding is supported by studies conducted on Batak ethnic students at HKBP Nommensen Medan University [10], as well as research conducted on Indian tribal communities in the Medan Sunggal area, which indicates that the average upper arm length of males is greater than that of females [11]. Similarly, the average measurement of the soles length of the feet in males also showed greater than those of females. This corresponds to studies conducted on students at Sam Ratulangi University in Manado [12] and research on Indian tribes in the Medan Sunggal area [13]. Both indicating that males have longer foot soles than females. Our result shows that average foot width of the sole on males was greater than females. However, previous research on anthropometric profiles of males and females in students of the faculty of medicine, Islamic University of North Sumatra revealed that the average width of male foot soles is greater than that of female foot soles [14]. This may be caused by physiological factors where female puberty begins and ends two years earlier than males [15]. At the age of 12, boys tend to grow faster than girls. During the

transition from adolescence to adulthood, males are generally taller and have longer limbs than females [4].

To the best of the author's knowledge, research on the correlation between upper arm length and sole length to body height has been conducted, but there has been no research on the correlation between foot sole width and body height. Based on Table 1, the results of the correlation analysis of height with upper arm length, sole length, and foot width was strong positive correlation. This may occur because the upper arm, which is included in the long bones, and the soles of the feet which mostly composed of long bones grow and develop along with the long bones that make up the height of the body [4, 16].

Table 1. Correlation of height with upper arm length, sole length, and foot width

Measurements	Spearman Correlation (r) to Height
Upper arm (right)	0,942
Upper arm (left)	0,947
Sole length (right)	0,885
Sole length (left)	0,891
Foot width (right)	0,765
Foot width (left)	0,772

Table 2, shows that sex influenced body height. The males body is larger compared to females due to by physiological factors where female puberty begins and ends two years earlier than males [15]. During the transition from adolescence to adulthood, males are generally taller and have longer limbs than females [4].

Table 2. Linear test results of height to sex model

Variable	Estimate	Std. Error	T value	Significant
Intercept	147,7820	2,4687	59,863	<2,2e ⁻¹⁶ ***
Sex (Male)	10,6607	0,9584	11,124	<2,2e ⁻¹⁶ ***

Based on Table 3, physical activity influenced height. Physical activity with high intensity can stimulate strain on the bones up to 1,000 microstrains. The result of this physical force will help maintain bone mass and the formation of bone structure [17]. High stress sports such as gymnastics or sports with weights can increase the peak growth of bone mass [18]. Based on this study, the intensity of physical activity did not show a significant influenced on height. This could be attributed to the unequal frequency of respondents.

Table 3. Linear test results of height model on physical activity

Variable	Estimate	Std. Error	T value	Significant
Intercept	147,7820	2,4687	59,863	$<2,2e^{-16***}$
Activity count ^a	1,7619	0,8209	2,146	0,034116 *
Intensity 3-4 times/week ^b	1,2593	1,2110	1,040	0,300750
Intensity 5-7 times/week ^b	5,8428	5,1038	1,145	0,254852
Intensity >7 times/week ^b	1,1420	2,9680	0,385	0,701171
Intensity 1 times/month ^b	7,1321	5,3274	1,339	0,183485

^a the number of activities performed during the growth period (0-20 years)

^b intensity of activities performed each week

Table 4, shows that milk consumption influenced height. The intensity of milk consumption for 5-7 times per week during the period of growth (0-20 years old) significantly influenced height. Milk consumption during growth is needed to help bone formation. Milk contains calcium, vitamin D, phosphorus, and protein which are useful in the process of bone growth [19]. Milk also contains Insuline Like Growth Factors (IGF-I) which has an important role in the growth of bone length. Growth Hormone (GH) will stimulate IGF-I which functions to increase osteoblast activity so that bone formation and growth occur [20].

Table 4. Linear test results of height model on milk consumption

Variable	Estimate	Std. Error	T value	Significant
Intercept	147,7820	2,4687	59,863	$<2,2e^{-16***}$
Milk consumption 3-4 times/week	1,6632	1,0564	1,574	0,118338
Milk consumption 5-7 times/week	3,6502	1,5582	2,343	0,021003 *
Milk consumption >7 times/week	3,1137	2,1143	1,473	0,143778
Doesn't like milk	-4,6333	4,8548	-0,954	0,143778

Based on Table 5, father's education influenced height. Parents who have a high level of education will have better knowledge and ability to apply this knowledge compared to those with low education. The implementation of such knowledge, for example, the understanding of nutrition and effective parenting to mitigate the stunted growth of children. [21].

Table 5. Linear test results of height model on father's education

Variable	Estimate	Std. Error	T value	Significant
Intercept	147,7820	2,4687	59,863	$<2,2e^{-16***}$
Junior high school	6,1336	2,9993	2,045	0,043306 *
Senior high school	7,0894	2,2761	3,115	0,002363**
D3	13,1208	3,5169	3,731	0,000307***
S1	8,1816	2,3461	3,487	0,000709***
S2	7,3264	4,1075	1,784	0,077316 .

4 Conclusion

This study found that upper arm length, sole length, and foot width were positively correlated with height in the community in East Jakarta. As a person's height increases, their upper arms and the soles of their feet tend to increase in length.

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