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RESEARCH ARTICLE

Determination of Height Based on Estimated Femur Length in Medan City

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Abstract : Identification checks are an important action to find out the identity of a person, other than living people, especially in the case of victims who have died or disappeared. The identification process used in the field of forensic anthropology is by the anthropometric method, by measuring one part of the body in determining the estimated height. The length of the inferior limbs has the most favorable correlation for human height. In this case, the femur is one of the parts of the body that is commonly used in height estimation. The femur section is the best parameter because it is in line with the anatomical structure of the body for the determination of height which is useful in a clinical context. The researcher is interested in researching height based on femur length in FK UMSU students class of 2019 This research method is an analytical descriptive research with *a cross-sectional design approach*. The research subjects were 113 students of FK UMSU stambuk 2019 consisting of men and women who met the inclusion and exclusion criteria. Sampling technique using *purposive sampling*. The length of the femur has a correlation value that ranges from 0.382 to 0.534 ($p \leq 0.001$). The linear regression equation obtained showed a Standard Error of the Estimate (SEE) ranging from 0.164 to 0.272 ($p \leq 0.001$). There is a meaningful relationship between femur length and height with such a strong correlation that height can be estimated by measuring femur length through linear regression equations.

Keywords: Femur length, height, regression equations, anthropometry

INTRODUCTION

In forensic medicine, identification checks are an important measure to find out the identity of a person, other than a living person, especially in the case of victims who have died or disappeared.[1] Identification is carried out in cases of accidents or natural disasters, such as aircraft, train or traffic accidents, cases of mutilation, cases of explosions or fires, and incidents that only leave part of the body tissue for identification. Therefore, for the

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sake of law and humanity, identification actions are carried out.[2] In addition to recognizing a person's identity, the purpose of the identification process is also to recognize the cause of death or a previous event, and is useful for providing psychological peace with the identity of the victim for the family.[3] The most important parameters in identifying are known as the *Big Four,* namely gender, race, age and estimated height.[2] In addition, weight, skin color, stature, muscular state, nutritional state, hair, eyes, teeth, scars, moles, tattoos, birthmarks or distinctive marks on body parts, clothing, jewelry or items on the victim, the presence or absence of mustache and beard in men, congenital or acquired body defects, need to be recorded as the identity of the victim, even if the victim is recognizable.[4]

Often the corpses taken to the hospital have been damaged or decayed, such as in mutilation victims or only in the form of bones that complicate the identification process. The identification process was carried out by assessing *the post-mortem* data found on the victim and then adjusted to *the ante-mortem* data obtained from the victim's family.[5] The identification process used in the field of forensic anthropology is by the anthropometric method, by measuring one part of the body in determining the estimated height.[6]

The field of anthropology anthropology is a branch of anthropology that has a basis in osteology and human anatomy, with the aim of identification for legal and judicial interests. Anthropological examinations are useful to identify whether the skeleton is of human or animal origin, and to find out the height, age, sex, and race of the body.[7] When only a partial body is found, height estimation is essential for *medicolegal needs*.[8]

Identification requires a mathematical method of reconstructing the height of an incomplete body skeleton.[9] Trotter and Glesser were the first anthropologists to create an estimation formula for determining human height. This has prompted many researchers to develop different formulas for diverse populations in the world.[10]

A 2013 study conducted by Nor FM explained that in the Malaysian population, the length of the lower extremities has the best correlation for human height.[11] The femur is one of the most commonly used long bones in height estimation.[12] Basically, the proportion of the length of the superior and inferior extremities is proportional to the height of the human body. So the length of the femur, tibia, and fibula is the most predictive resemblance, because these lower limbs function as the main contributor to the standing position.[13] Several studies on height estimates based on *femur length* have a strong correlation, such as the one conducted by Dewi in 2022 on students of the Faculty of Medicine, Baiturrahmah University,[14] Wulan 2021 in the Bugis tribe in Karang,[13] Kaintako in 2019 on ethnic Papuans in Tomohon,[15] Mulenga 2019 in Zambia,[9] Maulina 2018 on Acehnese ethnicity in Aceh,[9] and Obialor in 2015 in Nigeria,[16] states that there is a significant relationship between height in men and women and parts of their limbs, in this case the length of the femur that has the best correlation to height measurement because it is in line with the

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anatomical structure of the body. In another study by Tetteh in 2021 in Ghanaians, it was stated that the length of the left femur was the best parameter for men (62.1%) while the length of the right femur was the best parameter for women (57%).[16]

Therefore, based on the above background, researchers are interested in researching height based on femur length in FK UMSU students of the class of 2019.

METHOD

This type of research is in the form of descriptive analytical research that is conducted observationally with the aim of finding the relationship between height and femur length. The research design of the *cross sectional* study approach is that data collection is only carried out once in a certain time. The sample in this study must meet the inclusion criteria and the data used in this study is primary data and taken using *the purposive sampling* method.

Stages of data collection:

1. Provide *an informed consent sheet*
2. Measurement of femur length with an upright standing position, measured from *proximal trochanter major (greater trochanter)* to *distal condylus lateralis.*
3. Height measurement using *microtoise*, measured from the highest point of *the cranium (vertex)* to the lowest point of *the calcaneus bone (heel).*

The respondent did not wear footwear or head accessories and stood on a flat place. Both arms are placed at the sides of the body with one breath, chest is puffed and the stomach is flat. The back and heels are pressed against the wall while the head is facing straight forward.

The data obtained is numerical variable data. The correlation hypothesis is used when the connected variable is numerical. The data obtained will be tested for normality. The correlation test used is Pearson, when one of the variables is normally distributed. If some of the data is abnormal, the transformation is carried out. If the result of the transformation is abnormal, the Spearman correlation test is used. The data was then analyzed using linear regression analysis to obtain regression equations

RESULT

This research has received approval from the Health Research Ethics Commission, Faculty of Medicine, University of Muhammadiyah North Sumatra, No.880/KEPK/FKUMSU/2022. This study aims to obtain a regression formula for height based on femur length, so that an individual's height can be determined based on the estimated length of his femur. This study was carried out by measuring the height and length of the femur to assess the relationship between the two, which was carried out on a sample of FK UMSU students of the 2019 class.

Table 1. Frequency Distribution of Gender and Age

Age	Gender	
	Man	Woman
21 Y.o	19	29
22 Y.o	28	24
23 Y.o	8	5
Total	**55**	**58**

Based on the distribution of sex and age frequencies in table 1, information was

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obtained that of the 113 respondents used for the study, 19 respondents who were 21 years old who had a male gender, while those who had a female gender were 29 respondents. At the age of 22 years, 28 respondents were male, while 24 respondents were female. At the age of 23 years, 8 respondents had male gender, while 5 respondents had female gender.

Table 2. Height Measurement Results

Gender	Average (Standard Deviation)
Common	161,88 ± 7,411
Man	163,0784 ± 8,101
Woman	160,903 ± 6,698

The results of height measurement in table 2 obtained information that the average height of the male sex is longer than that of women.

Table 3. Femur Length Measurement Results

Gender	Average (Standard Deviation)
Common	38,14 ± 3,793
Man	38,745 ± 3,593
Woman	37,645 ± 3,909

Based on the results of femur length measurements in table 3, information was obtained that the average femur length of the male sex is longer than the length of the femur of the female sex.

Tabel 4. Kolmogorov Smirnov Normality Test Results

Gender	Variabel	P-Value
Common	Height	0,200
	Femur Bone Length	0,064
Man	Height	0,200
	Femur Bone Length	0,200
Woman	Height	0,071
	Femur Bone Length	0,052

Based on the results of the Kolmogorov Smirnov normality test in table 4, it is known that there is a probability value of p or Sig. > 0.05. Thus, it was decided that the assumption of normality was met, so the hypothesis was tested using Pearson correlation.

Table 5. Pearson Correlation Test Results

Correlation	Sum	Sig.	Correlation Coefficients
Common	113	<0,001	0,462
Man	55	<0,001	0,534
Woman	58	0,002	0,382

Based on the results of the Pearson correlation test in table 5, information was obtained that the relationship between height and femur length in general obtained a significance value of < 0.001, the value < 0.05, then H0 was rejected and H1 was accepted, which means that there is a relationship between height and femur length. At the correlation coefficient of 0.462, it means that the level of closeness of the relationship is included in the medium criterion. In the relationship between male height and femur length, a significance value of < 0.001 was obtained, the value < 0.05, H0 was rejected and H1 was accepted, which means that there was a relationship between male height and femur length. The correlation coefficient of 0.534 means that the level of closeness of the relationship is included in the medium criteria. In the relationship between female height and femur length, a significance value of 0.002 was obtained, < 0.05, H0 was rejected and H1 was accepted, which means that there was a relationship between women's height

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and femur length. The correlation coefficient of 0.382 means that the level of closeness of the relationship is included in the low criteria.

Table 6. Linear Regression Analysis Test

Variabel		Koefisien	SEE	P
Height in General	Femur bone length	0,902	0,164	<0,001
	Konstanta	127,480		
Height in Men	Femur bone length	1,203	0,272	<0,001
	Konstanta	116,453		
Height in Woman	Femur bone length	0,654	0,204	0,002
	Konstanta	136,275		

**SEE: Standard Error Of The Estimate*

Based on the table above, a linear regression equation can be formulated so that the relationship between femur length and height is obtained through the linear regression equation as follows:

1. Height based on the general estimate of femur length:
   Height (cm) = 127.480 + 0.902 x Fermur Length.
2. Height based on the estimated length of the femur in males:
   Male Height (cm) = 116,453 + 1,203 x Fermur Length.
3. Height based on the estimated length of the femur in females:
   Female Height (cm) = 136.275 + 0.654 x Fermur Length.

DISCUSSION

The sample used in this study is active students of the Medical Education Study Program at FK UMSU Class of 2019 with an age range of 21-23 years. Bone growth has stopped around the age of 21 so the age of the respondents in this study will not change. In this study, measurements were made on the length of the femur of men and women as well as their height.

Based on the results of the analysis in this study, from 113 samples with a total of 55 males and 58 females, it was found that the average and standard deviation of height of male respondents was 163.0784 ± 8.101 cm and female was 160.903 ± 6.698 cm. Then for the measurement of the femur length, it was found that the average and standard deviation of femur length for male respondents was 38.745 ± 3.593 cm and female was 37.645 ± 3.909 cm. The results of the analysis showed that the average height of the male sample was greater than that of the female. But it also showed that the standard value of deviation in the female sample was lower than that of the male, which means that the value of the female height was more accurate in approaching the average. As for the results of the analysis of this study, it can be seen that the height of men is longer than that of women.[1,2]

Previous studies have also shown similar results, namely by Kaintako, et al. (2019) on Papuan Ethnicity in Tomohon, which states that based on gender, men have a longer height than women. But also with a lower standard deviation value in the female sample, which means that the value

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of women's height is more accurate in close to the average. This study used 98 samples, namely 52 men with an average height of 160.56 and a standard deviation of 5.1 and 46 women with an average height of 152.59 and a standard deviation of 2.0.21. Likewise, a study conducted by Dewi, et al. (2022) on students of the Faculty of Medicine, Baiturrahmah University stated that the average height of men is greater than that of women, but with a standard deviation value that is also lower in women. This study used 38 samples, with 16 males and 22 females, with the results of mean height and standard deviation in males. 171.94 ± 5,302. Meanwhile, the results of the average height and standard deviation in women were 158.73 ± 4.626. So it can be concluded that the height of the male sex is longer than that of the female, with the degree of accuracy being more dominant in the female sex.[3,4,5]

Meanwhile, there are differences in the results of research by Lubis and Siregar (2022), in the 2018 batch of FK UISU students, using as man y as 60 samples with a total of 27 male samples and 33 female samples. It was obtained that the average height of men was 169.422 with a standard deviation of 5.9367 and the average height of women was 158.209 with a standard deviation of 7.3186. So it can be concluded that the height of the male sex is longer with a more dominant level of accuracy than the female gender.[6,7,8]

Human growth has occurred from the prenatal period to the age of 10 years. The baby's body length will increase by about 50%, which is as much as 12-13 cm in the first year after birth, then slow down by 5-6 cm per year before the growth spurt period in children occurs which will occur for about 2-2.5 years. Boys and girls generally have the same growth rate until the age of 10 years. After that is the growth spurt period of children which will differentiate the height growth speed of boys compared to girls. Growth spurt in boys occurs around the age of 12-13 years with the peak of growth at the age of 14 years and is able to reach about 20 cm in length and is more dominant in the upper body. Meanwhile, the growth spurt in girls begins around the age of 10-11 years with the peak of growth at the age of 12 years, with a height growth of about 16 cm. Therefore, girls' growth will stop faster and their growth span will be smaller than boys, which makes the height of adolescent boys greater than that of adolescent girls. When you reach adulthood, there will be a cessation of growth around the age of 18-20 years because there is maturation of the epiphyseal plate in the bone. In other words, this growth will stop at the moment when the metaphysis merges with the epiphysis. This causes the height of women to be unable to trick the height of adult men because it has to stop. Meanwhile, male height also stopped but with a growth spurt period that can trick women's height.[9.10,11]

In addition, genetic factors from parents greatly contribute to children's growth in terms of shape, proportion, and growth speed. The production and release of a hormone that triggers height is regulated by a gene, therefore the reason a child's height is predicted to be greatly

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affected by the genes carried by their parents. Insulin Hormone, like Growth Factors, is the most important hormone during the growth period. The liver and bone tissue are organs that produce IGFs that stimulate new bone cells (osteoblasts) in the epiphyseal and periosteal tissues, and increase protein synthesis for the needs of new bones. Hormon lain juga berfungsi mendorong pertumbuhan tulang seperti hormon tiroid, testosteron dan estrogen. Thyroid hormones stimulate osteoblasts and increase protein synthesis for bone growth. The hormones testosterone and estrogen function as the development of the bone extracellular matrix and trigger the activity of osteoblasts and function as bone remodeling in adulthood. Therefore, in this growth hormone, its maturity status is regulated by genes that are highly affected by the parents, to produce and release growth hormone from the endocrine glands, then stimulate cell growth and tissue development that causes the height growth of the child.[12,13,14]

Anatomical factors also affect sex, such as adult males have a leg size that tends to be longer, bone size tends to be heavier and muscles tend to be denser with a larger size. Adult females are shorter due to smaller bone sizes and less muscle mass and tend to have more subcutaneous fat.18 Naturally, women's skeletons are smaller and more susceptible to greater microarchitectural damage than men's. So that with this, the height of men tends to be longer than women.[15,16]

Based on the results of the correlation test in this study, a significant relationship between height and femur length in men and women was obtained. The results of this study show that the length of the femur in men has a correlation value of 0.534 (medium) with a significance value of < 0.001 while the length of the femur in women has a correlation value of 0.382 (low) with a significance value of 0.002. The p-value < 0.05 which means that there is a uniform and significant relationship between height in men and women and the length of their femurs. So with this, if the length of the femur increases, it will also increase the height and vice versa. This result is in accordance with research at the Faculty of Medicine, Baiturrahmah University by Dewi, et al. (2022) which obtained a direct proportional equality between height and femur length with a correlation value obtained between the length of the right femur and the height of the body in men of 0.968 (very strong) with a p-value of < 0.001 while in women it has a correlation value of 0.631 (strong) with a p-value of < 0.001.20 In addition, the results of this study are also in line with the research in Tomohon, Kakaskasen III Village on Papuan Ethnicity by Kaintako, et al. (2019) the results of this study show that there is a fairly strong and positive relationship between femur length and height with a correlation coefficient value (r) in the overall sample of r = 0.569 and a value in the male sample of r = 0.436 while in the female sample of r = 0.279.[1,5]

Based on the results of linear regression analysis, it is possible to estimate the height of an individual based on the estimated length of his femur. The

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equation has a Standard Error of the Estimate (SEE) that ranges from 0.164 to 0.272. With a male result of 0.272 and a female result of 0.204 and an overall result of 0.164. SEE is a good parameter to show the correlation between the original value and the approximate value. The smaller the SEE value, the stronger the accuracy of the linear regression equation. The female sample in this study had a lower SEE value (0.204), which means that the accuracy of the linear regression value of women was more dominant than that of men. The results of this study are to show that there is a meaningful relationship between height and femur length. So that with this it can be determined the estimated height using a formula from the length of the femur. These results are in accordance with research at the Faculty of Medicine, Malikussaleh University, Aceh by Maulina (2018), using 43 samples, resulting in a male SEE value (0.307) and a female SEE value (0.277). This explains that women show more accurate results of linear regression equations. But it is not in accordance with the research that has been conducted by Mulenga, et al. (2021) at a university in Kumasi, Ghana, which used 505 samples, with 261 male sex and 244 female sex. This study showed the results of male SEE (4.92) and female SEE (5.92) where in the study men had lower SEE scores. So it can be concluded that in this study, men have more accurate results of linear regression equations.[5,6]

The factors that underlie the difference and influence of the femur with height are genetics, differences in the location of residence and also related to the food a person consumes. Research conducted by Wulan and Dyah (2018) on adult men from the Lampung and Javanese tribes in Tanggamus, showed results that people living on the coast will consume more seafood that contains a lot of vitamins and minerals so that it makes height growth better than those who rarely consume seafood.61 Apart from genetics, gender and dietary factors, physical activity also affects a person's height. A person's work varies in length and radius. The use of muscles at work will affect a person's height. For example, a person who in his daily life actively uses great hand strength such as an athlete, blacksmith, fisherman, farmer will be different from someone whose work or daily activities do not require much hand muscle strength such as an office worker. Basically, the physical characteristics of each human being are different such as race, genetics, gender, age, climate, and nutritional status. This affects the process of human growth and development.[13,16]

CONCLUSION

The conclusion obtained from the results of this study is that the length of the femur affects a person's height. However, there is a difference between the length of the male and female femur which causes a difference in height as well. The longer the size of the femur, the higher the height of a person.

REFERENCES

1. Parinduri AG. Identifikasi Tulang

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Belulang. *Anatomica Medical Journal Fakultas Kedokteran*. 2018;1(1):1-13.
2. Nuha IU, Handayani S, Afifah ZN. *Estimasi Tinggi Badan Berdasarkan Panjang Demispan Dan Panjang Femur Pada Mahasiswa Fakultas Kedokteran UNS Surakarta*.; 2017. Accessed July11,2022.
3. Prawestiningtyas E, Algozi AM. Identifikasi Forensik Berdasarkan Pemeriksaan Primer dan Sekunder Sebagai Penentu Identitas Korban pada Dua Kasus Bencana Massal. *Jurnal Kedokteran Brawijaya*. 2009;25(2):87- 94.
4. Rosmawaty, H. Mistar R, H. Guntur Bumi N. *Penentuan Tinggi Badan Berdasarkan Panjang Lengan Atas*.; 2013.
5. Amri A. *Rangkaian Ilmu Kedokteran Forensik (Edisi Ke-2)*. Vol 2. 2nd ed. Fakultas KedokteranUniversitas Sumatra Utara; 2008.
6. Kanchan T, Krishan K. Personal I dentification in Forensic Ex.*Anthropology*. 2013;2(1):8-10.
7. Hidayat T. Analisis Antropologi Forensik Pada Kasus Penemuan Rangka Di Dalam Koper. In: Susanti R, ed. *Perhimpunan Dokter Forensik Indonesia, Prosiding Pertemuan Ilmiah Tahunan 2017*. Prosiding Pertemuan Ilmiah Tahunan 2017; 2017:281-285. Accessed July 11, 2022.
8. Kusuma S, Yudianto A. *Identifikasi Medikolegal. In: Hoediyanto Dan Apuranto, H. Ilmu Kedokteran Forensik Dan Medikolegal.* . Vol 7.; 2010.
9. Soedjatmiko HM. *Ilmu Kedokteran Forensik*. Vol 2.; 2001.
10. Sicca PS. Kecelakaan Kereta Api Sepanjang Sejarah di Berbagai Negara dari Abad Ke-20. *kompas*. https://s.id/1drqA. Published April 2, 2021. Accessed July 30, 2022.
11. Arnani M, Wedhaswary DI. Gempa dan Tsunami di Jepang. *kompas*. https://s.id/1drnu. Published March 11, 2021. Accessed July 30, 2022.
12. Putra AY, Assifa F. Korban Kecelakaan Bus Sriwijaya Sulit Diidentifikasi, Polisi Kirimkan Tim DVI . Kompas. Published December 24, 2019. Accessed August 19, 2022.
13. Agustini D. Beberapa Jenazah Korban Kebakaran Lapas Kelas 1 Tangerang Sulit Diidentifikasi. Kabar Banten. Published 2021.
14. BBC News Indonesia. Gempa Palu: Korban meninggal 1.948, hilang 843, "ribuan mungkin terkubur." BBC News Indonesia.
15. Ekkarandy DR, Arafat MR. Identifikasi Forensik Terhadap Korban Kecelakaan Massal (Pesawat) Di Tinjau Dari Ilmu Kedokteran Forensik. *Jurnal Hukum POSITUM*. 2021
16. INTERPOL DVI Guide. *Disaster Victim Identification Guide, Annex 12: Methods of Identification*.; 2018.