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RESEARCH ARTICLE

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STATURE ESTIMATION FROM FOOT DIMENSIONS FOR HUMAN IDENTIFICATION: A VALIDATION STUDY

Caroline Freitas Souza Plácido*[1], Carolina Lucena Veloso Gusmão[1], Viviane Moura Leite[2], Gabriela Granja Porto Petraki[3], Adriana Conrado de Almeida[3] and Antônio Azoubel Antunes[3]

[1]Master in Forensic Scienceat University of Pernambuco/Faculty of Dentistry of Pernambuco (UPE/FOP); [2]Forensic and Legal Odontologist of the State of Amazonas, Master in Forensic Scienceat University of Pernambuco/Faculty of Dentistry of Pernambuco; [3]PhD, AssociateProfessor at University of Pernambuco, Brazil

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****Corresponding author:***
Caroline Freitas Souza Plácido

ABSTRACT

Objective: To validate the equation obtained by correlating the means of foot anthropometric measurements with the stature of individuals for human identification purposes. **Methods:** Cross-sectional, prospective, convenience sampling study with a sample of 450 individuals that met the pre-established inclusion criteria. Stature, foot anthropometric measurements, and footprint impressions of all participants were measured. Data were analyzed statistically by the software IBM SPSS, version 23. A significance level of 5% ($p \leq 0.05$) was adopted. **Results:** Significant differences ($p < 0.001$) were recorded between sexes for each of the analyzed variables. The mean estimated stature was correspondingly higher than the actual stature, with the mean differences being – 2.59 for males, - 4.25 for females, and – 3.41 for the entire group. Differences in mean percentage were of -1.56% for males, - 2.74% for females, and -2.15% for the entire group. Agreement of 0.75 between statureswith a 95% confidence interval was observed. **Conclusion:** The means of foot measurements and footprint impressions were higher for men. The stature estimated by the equation was greater than the actual stature. The equation presented goodaccuracy, enabling the application of this method for the population.

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INTRODUCTION

Human identification is an extremely important step in civil and criminal proceedings. Identity is the set of physical, functional, and psychological characteristics, normal or pathological, that individualize individuals, making them distinct and unique (PEREIRA, 2012). Regarding physical characteristics, age, sex, anatomical malformations, stature, marks, scars, tattoos, individual signs, and the biotype stand out. Regarding functional characteristics, attitude, mime, walking, gestures, sensory functions, writing, and voice stand out (VANRREL, 2009). Forensic identification is essential for not only humanitarian reasons, but also for civil and/or criminal investigation. It is essentially based on forensic anthropology, dentistry, and pathology, and may use complementary methodologies such as radiographic analysis, computerized tomography, and DNA profile analysis (KAWAMOTO *et al*., 2015). The stature and various body parts, such as the head, torso, and upper and lower limbs have an established correlation. This allows a forensic specialist to estimate stature from different body parts. Since there are an increasing number of mass disasters, homicides, and plane, train, and car accidents, among others, there is always a need for studies to help identify fragmented or dismembered human remains. In these situations, hand and foot anthropometric measurements have a good correlation with the stature of an individual (KRISHAN and SHARMA, 2007; NACHIKET *et al*., 2010; KRISHAN *et al*., 2012; PAWAR and PAWAR, 2012; PABLOS *et al*., 2013). In daily forensic practice, footprint impressions can be used when found in crime scenes on the ground, on hard surfaces, and in stains of blood, paint, and other liquids, being collected through photographs, drawings, and measurements with standardized instruments, such as rulers, compasses, and calipers, among others. In addition, the stature estimation of a full skeleton or parts of mutilated limbs has its meaning in forensic identification analyses. In the forensic aspect, it is crucial to describe the suspects' hand and footprints at crime scenes (KRISHAN and SHARMA, 2007; KANSHAN *et al*., 2013; GROOTE and HUMPHREY, 2011). Many studies that estimate stature from different nutritional aspects and physical activities have shown variations in the different populations studied, proving to be satisfactory in this topic despite the wide ethnic and racial vastness of the populations (OZASLAN *et al*., 2012; AGNIHOTRI *et al*., 2007; FAWZY and KAMAL, 2010; WEBB *et al*., 2014; DAMJANIC *et al*., 2015). The identification or exclusion of a suspect or victim through footprints left at crime scenes are simple, low-cost, and effective processes. This study aims to validate the equation obtained in a previous study (unpublished data), in which positive correlation was observed between foot anthropometric measurements and the stature of individuals in a Brazilian population for purposes of human identification. Therefore, the equation has its accuracy and feasibility of practical application in the forensic context verified.

MATERIALS AND METHODS

This research was approved by the Research Ethics Committee (REC) at University of Pernambuco under the number 54585015. 0.0000.5207, in accordance with the resolution number 466/2012 of the National Health Council and the Declaration of Helsinki VI, promulgated in 2000. All participants were informed on the content of the study and those who freely agreed signed the free and informed consent (FIC). This is an anthropometric, cross-sectional, prospective, analytical, descriptive, and randomized study. The total sample consisted of 450 volunteers, equally divided between sexes (225 men and 225 women), selected by convenience sampling in various locations in the Metropolitan Region of Recife. Individuals with foot deformities and/or morphological alterations that compromised footprint recording; presence of diseases that affect the spine and interfere with posture; and individuals who did not present both feet in their body structure or five toes on each foot due to amputation, loss of anatomical segments or polydactyly were excluded. All individuals over 18 years old who signed the informed consent were included. Participants were instructed to stand upright with their backs against the wall and their arms at their sides without any headgear and barefoot. The toes of the feet were parallel or slightly divergent and the head was positioned in the Frankfort horizontal plane when the stature was measured using a measuring tape fixed to the wall. The measurement of this step was performed by a different researcher from the one who collected footprints, so that there was no influence on the stature estimate obtained from the equation and the actual stature of the participant.

Anthropometric measurements were taken directly from the feet of the research participants, using a digital caliper, from a more posterior heel midpoint (Pternion) to the most prominent point of each toe (T), being classified in order from the innermost (halllux) to the outermost toe as T1, T2, T3, T4, and T5. The same reference points were used to measure the distances verified in the footprint impressions (Figure 1).

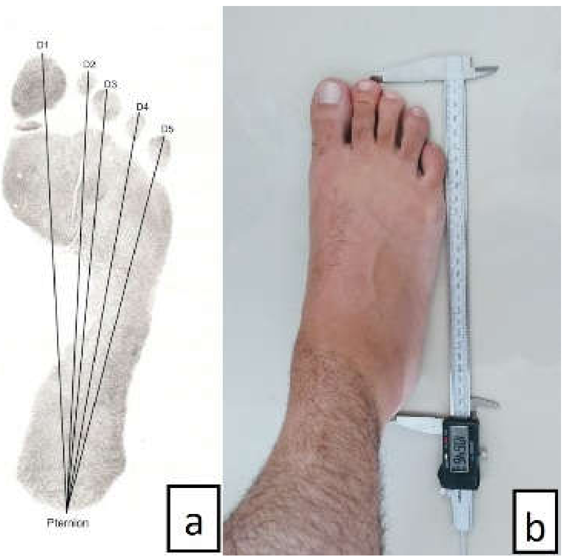


Figure 1. (a) reference points for measuring the distances between the Pternion point and the tip of the toes in the footprint. (b) Use of the caliper to measure distances directly on the feet

In order to collect the footprint, a podograph was used. Using a roller, the foot soles were covered with ink for impression. Then, an A4 paper sheet was placed behind the podograph and the research participants were instructed to place their feet on the podograph, one at a time, and apply regular pressure. The PodoTech® (State of Paraná, Brazil) podograph was used. For measurements directly on the feet, a Zaas (Zaas Precision Co., China) digital caliper, 150 mm, was used by sliding the caliper shaft from the Pternion point towards each toe and always resetting the caliper after each measurement (Figure 2).

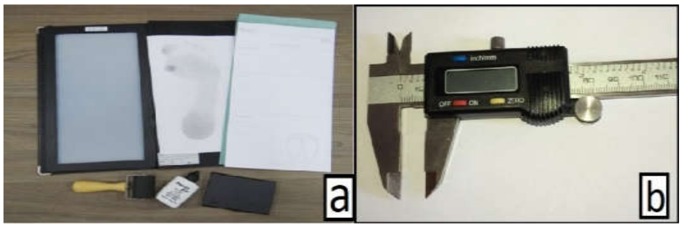


Figure 2. Instruments for collecting distances. (a) Podograph by PodoTech® (State of Paraná, Brazil). (b) Zaas Digital Caliper, 150 mm (ZaasPrecisionCo., China)

Before data collection, the examiners were calibrated according to the method developed by Dangour (KRISHAN, 2008a), in which 30 individuals were adopted as examples and their individual measurements were taken twice. This number was not included in the sample.

After collecting the anthropometric measurements, these data were entered into the following equation:

$Stature_{estimated} = 42.54 + 5.51 \times$ Mean measurements (T1, T2, T3, T4, and T5)

This equation was obtained from a previous study by the present study group. After obtaining the estimated stature, the value was compared to the actual stature of the individual in question. The accuracy level between the two values obtained was statistically determined. Data were stored in Office Excel 2013 (Microsoft) spreadsheets, creating a database with all variables. These variables were analyzed using the Statistical Package for the Social Sciences (SPSS), version 23.0 (IBM Corporation, New York, U.S.A.). Descriptive statistics of the absolute and percentage differences between the estimates of the equations obtained from the study in which the equation was created and from the two ways of estimating stature performed in this study were obtained. The margin of error used in deciding the statistical tests was 5% ($p<0.05$) and the interval for agreement was obtained with 95% confidence. The Student's t test with unequal variances or the Mann-Whitney test were used to compare sexes. In order to compare the actual stature and the stature estimated from the equation, the Wilcoxon paired test was used. The degree of agreement between the two measures was performed using the correlation coefficient for assessing agreement and the respective confidence interval for that parameter. When data presented normal distribution for both categories, such as for sex, for example, it was necessary to use the Student's t test, while the Mann-Whitney and Wilcoxon paired tests were used in the case of absence of normality. The Shapiro-Wilk test was used to verify normality and Levene's test was used to verify the equality of variances.

RESULTS

During the intra-examiner calibration described above, the mean value of 0.81 was obtained in the Kappa agreement test, demonstrating excellent correlation between the measurements taken by the examiner at the two different moments. The statistics of the variables mean toe length, mean toe length measurements in relation to footprint length, and actual stature by sex and by group are shown in Table 1.

Table 1. Variable statistics in cm: Mean toe length, mean footprint length, and actual stature in the entire group and separated by sex

Variable	Male	Female	Total group	P value
	Mean ± SD	Mean ± SD	Mean ± SD	
Mean toe length	22.83 ± 1.43	21.82 ± 1.22	22.84 ± 1.66	$p^{(1)} < 0.001$*
Mean footprint length	23.12 ± 1.26	21.25 ± 1.07	22.18 ± 1.50	$p^{(2)} < 0.001$*
Actual stature	171.25 ± 7.45	158.64 ± 6.44	164.95 ± 9.39	$p^{(2)} < 0.001$*

(*) Significant difference
(1) By Mann-Whitney test
(2) By Student's t test with unequal variances.

Table 2. Results of linear regression equations for estimating stature with data from Study 1 and 2

Author	Equation		R^2
Study 1	1.	$Stature_{estimated}$= 42.54 + 5.51 x mean foot length (cm)	0.714
Study 1	2.	$Stature_{estimated}$= 57.015 + 5.007 x mean foot length (cm) + 2.180 x sex (1)	0.721
Study 2	3.	$Stature_{estimated}$= 61.056 + 4.55 x mean foot length (cm)	0.645
Study 2	4.	$Stature_{estimated}$= 50.297 + 5.17 x mean footprint length (cm)	0.677
Study 2	5.	$Stature_{estimated}$= 81.323 + 3.54 x mean foot length (cm) + 5.572 x sex (1)	0.701
Study 2	6.	$Stature_{estimated}$= 70.379 + 4.154 x mean footprint length (cm) + 4.845 x sex (1)	0.717

(1) Considering: 0 = female and 1 = male.

Table 3. Statistics of differences between stature estimates obtained according to Equations 1, 2, and 3 in Table 2

Difference between equations	Mean ± SD	Minimum value	Maximum value
Absolute between (1) – (2)	3.41 ± 1.59	- 4.52	7.40
Percentage between (1) – (2)	1.98 ± 0.87	- 3.68	3.87
Absolute between (1) – (3)	3.43 ± 4.05	- 34.10	23.31
Percentage between (1) – (3)	1.96 ± 2.72	- 27.75	12.52
Absolute between (2) – (3)	0.02 ± 3.46	- 29.58	16.81
Percentage between (2) – (3)	-0.01 ± 2.33	- 23.22	9.36

(1) Equation 1 in Table 2; (2) Equation 2 in Table 2; (3) Equation 3 in Table 2.

Table 4. Actual stature statistics, stature estimated through the equation and difference between the two statures in the entire group and separated by sex

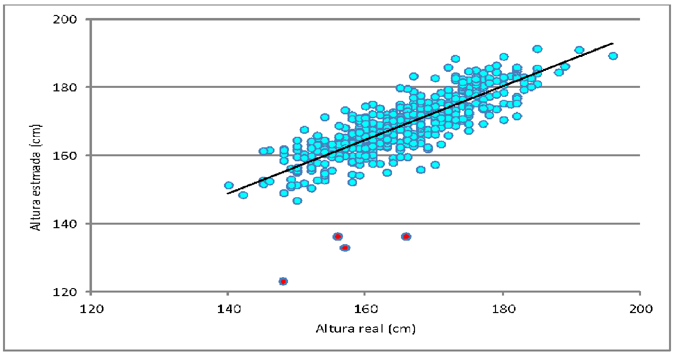
	Stature				
Sex	Actual	Estimated	Difference (actual – estimated)		P value
			Absolute	Percentage	
Male	171.25 ± 7.45	173.84 ± 7.86	- 2.59 ± 5.89	- 1.56 ± 3.52	$p^{(1)} < 0.001$*
Female	158.64 ± 6.44	162.89 ± 6.73	- 4.25 ± 5.64	- 2.74 ± 3.63	$p^{(1)} < 0.001$*
Entire group	164.95 ± 9.39	168.36 ± 9.13	- 3.41 ± 5.82	- 2.15 ± 3.62	$p^{(1)} < 0.001$*

(*)Significant difference at 5%
(1) By Wilcoxon paired test.

Table 5. Correlation coefficient for agreement between actual and estimated stature in the entire group

Correlation coefficient for agreement	
Value	95% confidence interval
0.75	0.71 – 0.79

This table shows that the mean measurements were correspondingly higher among male participants, with the highest absolute difference being verified in stature. Significant differences ($p < 0.001$) were recorded between sexes for each of the analyzed variables. The variability expressed by the standard deviation was reduced since the values of that measure corresponded for less than 1/3 of the corresponding means. Table 2 presents the linear regression equations obtained in the study in which the equation was created (Study 1) and in this validation study (Study 2). It is highlighted in this Table that, in the simple equations (involving only stature as dependent variable and the mean measurements of toe length or footprint length as an independent variable), it is possible to observe that the angular coefficient of the equation with the independent variable of mean toe length was higher in Study 1 than in Study 2 (5.51 x 4.51), while the linear coefficient was higher in Study 2. The angular coefficient (when considered as an independent variable) of mean toe length in Study 1 and of the mean footprint length in Study 2 were 0.34 higher in Study 1 (5.51 x 5.17), while the linear coefficient was 7.757 (50.297 x 42.54) higher in Study 2. The R^2 values ranged from 0.645 to 0.714. The inclusion of the sex variable increased the R^2 value from 0.645 to 0.701 with mean toe length and from 0.677 to 0.717 when considering mean footprint length. All angular and linear coefficients in all equations were statistically significant ($p < 0.001$). Table 3 analyzes the mean, standard deviation, and minimum and maximum values of the absolute and percentage differences between the estimates of Equations 1 to 3 in Table 2. This Table shows that the mean differences were always lower than 3.50 and positive, which indicates that the trend of the equation obtained in Study 1 produces higher estimates than those obtained in Study 2. The mean differences between the equations obtained through mean toe length and footprint length were close to zero. Table 4 shows the statistics of actual and estimated stature obtained by the equation from Study 1 and with data from Study 2, as well as the differences between the two measures aforementioned. It is noteworthy that the mean estimated stature was correspondingly higher than the actual stature, with mean differences being -2.59 for males, -4.25 for females, and -3.41 for the entire group. Mean differences in percentage were -1.56% for males, - 2.74% for females, and - 2.15% for the entire group. The statistical test indicated significant difference between the two statures for the entire group and for each sex.



Source: Own authorship.

Graph 1. Dispersion of actual stature with estimated stature

Graph 1 shows the dispersion of actual stature with the estimated stature of the sample measured in cm, according to the equation. Given what was found in the limit of agreement, the equation may have positive accuracy, since it presented less difference between means (actual and estimated stature) and a smaller number of individuals outside the limits of agreement (red colored dots). Table 5 shows the agreement between the two measurements (actual and estimated statures using data from Study 2 with the equation from Study 1), in which the assessment using the concordance correlation coefficient (CCC) obtained the value of 0.75 with a 95% interval, ranging from 0.71 to 0.79. The CCC ranges between 0 and 1, and can be interpreted as follows: CCC<0.4 is poor; 0.4≤CCI<0.75 is satisfactory to good; and CCC≥0.75 is excellent.

DISCUSSION

In view of the statistical analysis with sample data, the values of foot anthropometric measurements were higher in males, similarly to some studies recently published in the same area (KIM; KIM; YUN, 2018; ZHANG *et al*., 2017; UHROVÁ *et al*., 2015; GWANI *et al*., 2017). In contrast, Domjanic *et al*. (2015) analyzed foot anthropometric measurements of women noted that they were narrower and with smaller toes, as stated in another study. The size differences found between sexes may be related to the difference in growth associated with biological and/or genetic factors. Significant differences ($p < 0.001$) were recorded between sexes in each of the variables analyzed (mean toe length, mean footprint length, and mean actual stature) as also mentioned by other authors recently (KIM; KIM; YUN, 2018; ZHANG *et al*., 2017; UHROVÁ *et al*., 2015; GWANI *et al*., 2017). Although the races and ethnicities of the participants included in the current study were not assessed (reiterating that the sample is exclusively Brazilian), it is known that a large part of the Brazilian population consists of mixed individuals. This miscegenation resulted from the arrival of the Portuguese in association with the native peoples and subsequently afro-descendants. Thus, it was assumed that the Brazilian population has a particularity related to race, presenting European, indigenous, and African genetic traits, besides diversified habits and cultures (PETRIBU *et al*., 2012).

The results obtained in the study suggest that foot dimensions can be used in Forensic Science as predictive values to estimate the stature of individuals. The literature has reports that the dimensions of the lower extremities of the human body are more associated with the stature of individuals (OZASLAN *et al*., 2003; FESSSLER; HALEY; LAL, 2005). Although the statures estimated by the equation were greater than the actual statures, agreement was statistically noted between the actual stature and the estimated stature, which was assessed using the concordance correlation coefficient with a value of 0.75 in a 95% confidence interval. Thus, the statures are considered concordant, since the results between 0.4 and 0.74 are satisfactory and between 0.75 and 1 are excellent, according to Fleiss (1981). According to Graph 1, which shows the dispersion of the actual stature with the estimated stature of the sample measured in cm and according to the equation, a high number of dots can be observed close to the line of the limit of agreement. In this limit of agreement with a 95% confidence interval (values between 0.71 and 0.79), the equation presented a value of 0.75. It is noticeable that the blue dots approach the line, while the four red dots (approximately 1% of the sample) move away from the limit line of agreement and consequently from the blue dots, in which the values of estimated stature and actual stature of the red colored dots differed from the others. It is possible to observe a smaller difference between means (actual and estimated stature) and a minimum number of individuals located outside the limits of agreement (red colored dots), being positive for the accuracy of the equation. The identification of stature and other parameters is essential for forensic science to assess the biological characteristics of an individual (CATTANEO, 2007; KHAROSHAH *et al*., 2011). In studies like this one, in which the objective is to identify a correlation between stature and body parts, it is common to use regression analysis (CHIKHALKAR *et al*., 2010). In view of the high correlation between foot and toe measurements with the estimated stature, established through the foot anthropometric measurements, the means measurements of foot length and toe length were obtained regardless of the side assessed. In this study, the linear regression equations to estimate stature and R^2 values ranged from 0.645 to 0.714. The inclusion of the sex variable increased the R^2 value from 0.645 to 0.701 with mean toe length and from 0.677 to 0.717 when considering the mean footprint length. All angular and linear coefficients in all equations were statistically significant ($p < 0.001$), which also favors the coherence of the analyzed data and the accuracy of the equation, unlike other studies where the R^2 value was less than 0.6 and varying the statistical significance (KIM; KIM; YUN, 2018; UHROVÁ *et al*., 2015; GWANI *et al*., 2017).

After exposing the data collected and analyzed after applying the equation to be validated, such as the excellent concordance correlation coefficient (0.75), the dispersion graph of actual and estimated stature with approximately 99% of dots close to the limit line of agreement, and the statistical significance ($p < 0.001$) between all angular and linear coefficients in all equations obtained in the statistical analysis, the accuracy presented by the equation is considered good, thus enabling the application of this method by forensic specialists for estimation of stature from foot anthropometric measurements. As study limitations, females were more acceptable to the study than males during data collection, as males presented greater resistance to participate due to the need to remove the shoes. This fact extended the data collection time and made it necessary to expand the collection sites. The research carried out in this study aimed to validate the equation developed by Moura in 2017. The validation of this equation, based on foot anthropometric measurements and footprints, will be useful in cases of human identification and will be of great value in the daily practice of the forensic specialist, mainly in the estimation of stature in cases in which limbs are frequently found in isolation. The use of this equation can quicken the services of the forensic specialist and also help quicken body identification, for example. The impact of using the equation can be positive in the forensic practice. This study was the first to use the equation described above. It is necessary that further studies are carried out in order to further prove its validity and accuracy, despite the reliable and clear results of this study. The intention of this equation is to facilitate the work of the forensic specialist in human identification based on foot anthropometric measurements and stature estimation. It is hoped that the results can encourage other researchers from different regions to carry out new research and subsequent scientific publications on the subject, besides contributing with new knowledge in the forensic practice.

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CONCLUSION

The good accuracy found in the application of the equation allows this method to be applied as a forensic alternative in estimating the stature of individuals in the studied population. However, it is suggested that specific validation studies should be carried out for different populations.

REFERENCES

Agnihotri A. K., Purwar B., Googoolye K., Agnihotri S., Jeebun N. (2007) Estimation of stature by foot length. Journal of Forensic and Legal Medicine, 14:279-283.

Cattaneo, C. (2007) Forensic anthropology: developments of a classical discipline in the new millennium. Forensic science international, v. 165, n. 2-3, p. 185-193.

Chikhalkar, B. G. *et al*. (2010) Estimation of stature from measurements of long bones, hand and foot dimensions. J IndianAcadForensicMed, v. 32, n. 4, p. 329-33.

Domjanic J., Seidler H., Mitteroecker P. (2015) A combined morphometric analysis of foot form and its association with sex, stature and body mass. American Journal of Physical Anthropology, 157:582-591.

Fawzy I. A., Kamal N. N. (2010) Stature and body weight estimation from various footprint measurements among Egyptian Population. Journal of Forensic Sciences, 55:884-888.

Fleiss, J. (1981) Statistical methods for rates and proportions. New York: John Wiley & Sons.

Groote I. D., Humphrey L. T. (2011) Body Mass and stature estimation based on the first metatarsal in humans. American Journal of Physical Anthropology, 144:625-632.

Gwani, Abdullahi Suleiman *et al*. (2017) Estimation of stature from radiographic measurement of foot dimensions: Truncated foot length may be more reliable than full foot length. Journal of forensic and legal medicine, v. 46, p. 53-57.

Kanchan T., Krishan K., Geriani D., Khan I. S. (2013) Estimation of stature from the width of static footprints – Insight into an Indian model. The Foot, 23:136–139.

Kawamoto O. I., Ishikawa T., Michiue T., Mustafa A. M. H., Sogawa N., Karou T., Oritani S., Maeda H. (2015) Possible application of CT morphometry or the calcaneus and talus in forensic anthropological identification. International Journal of Legal Medicine, 1258-1263.

Kharoshah M. A., Zaki M.K., Galeb S. S., Moulana A. A., Elsebaay E. A. (2011) Origin and development of forensic medicine in Egypt. J Forensic Leg Med. 18(1): 10-3.

Kim, Wonjoon; Kim, Yong Min; Yun, Myung Hwan. (2018) Estimation of stature from hand and foot dimensions in a Korean population. Journal of forensic and legal medicine, v. 55, p. 87-92.

Krishan K. (2008) Determination of Stature from foot and its segments in a North Indian population. The American Journal of Forensic Medicine and Pathology, 29:297-303.

Krishan K., Kanchan T., Passi N., Dimaggio J. A. (2012) Stature estimation from the length of the growing foot – A study on North Indian adolescents. The Foot, 22:287-293.

Krishan K., Sharma A. (2007) Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine, 14:327-332.

Nachiket S., Sujatha N., Priya R., Raveendranath V., Rema D., Roopa R. (2010)

Ozaslan A., Iscan M. Y., Ozaslan I., Tugcu H., Koç S. (2003) Estimation of stature from body parts. Forensic Science Internacional, 32:40-45.

Ozaslan A., Karadayi B., Kolusayin M. O., Kaya A., Afsin H. (2012) Predictive role of hand and foot dimensions in stature estimation. RomanianJournalof Legal Medicine, 20:41-46.

Pablos A., Gomez-olivença A., Garcia-perez A., Martinez I., Lorenzo C., Arsuaga J. L. (2013) From toe to head: use of robust regression in stature estimation based on foot remains. Forensic Science Internacional, 226: 299-299.

Pawar R.M., Pawar M. N. (2012) Foot length – a functional parameter for assessment of height. The Foot, 22:31-34.

Pereira C. (2012) MedicinaDentáriaForense.Lisboa, Lidel.

Petribu, Marina de Moraes Vasconcelos *et al*. (2012) Desenvolvimento e validação de equação preditiva da gordura visceral em mulheres jovens. Rev. bras. cineantropom. desempenhohum., Florianópolis , v. 14, n. 3, p. 333-342.

Reliability of inter-anterior superior iliac spinous as compared to foot length for stature estimation in South Indians. Journal of Forensic and Legal Medicine, 17:352-354.

Uhrová, Petra *et al*. (2015) Estimation of stature using hand and foot dimensions in Slovak adults. Legal medicine, v. 17, n. 2, p. 92-97.

Vanrell J. (2009) Odontologia Legal e Antropologia Forense. Rio de Janeiro, Guanabara Koogan.

Webb D., Robu M., Moldovan O., Constantin S., Tomus B., Neag I. (2014) Ancient human footprints in Ciur-Izbuc Cave, Romania. American Journal of Physical Anthropology, 155:128-135.

Zhang, Xinghua *et al*. (2017) Estimation of stature by using the dimensions of the right hand and right foot in Han Chinese adults. Science China Life Sciences, v. 60, n. 1, p. 81-90.

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