Ain Shams Journal of Forensic Medicine and Clinical Toxicology
January 2023, 40:54-60

Middle Finger Length: A Predictor of Stature and Gender in a Sample of Egyptian Medical Students - Faculty of Medicine-Ain Shams University

Noha Farid Diab, Walaa Talaat Tawfik [1]

[1] Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Ain Shams University, Cairo Egypt.

Abstract

Background: Identification is one of the cornerstones in forensic investigations. Prediction of stature represents a vital parameter for reaching the partial identification of an unidentified body; moreover, gender determination of the body can exclude half of the population. **Aim of the study:** To assess the middle finger length as a predictor of stature and gender. **Methods:** A cross-sectional study was conducted on a sample of medical students who attended the Department of Forensic Medicine and Clinical Toxicology, Faculty of Medicine, Ain Shams University, after obtaining ethical clearance from the ethical committee. Data on age, gender, height, and middle finger length were collected. **Results**: The total number of participants in this study was 200 (100 males and 100 females) aged from 18 to 25 years. There was a positive correlation between middle finger length (MFL) and stature in both males and females. As regards gender determination, the most sensitive variable was left middle finger length (L MFL) with 100% sensitivity (and the most specific and accurate test was right middle finger length (R MFL) with 65% specificity. **Conclusion:** The study of middle finger length can help in stature and gender estimation among the Egyptian population.

Received in original form: 4 November 2022 Accepted in a final form: 10 January 2023

Key words Identification, stature, gender, middle finger length, Ain Shams University

Introduction

Identification is one of the cornerstones in forensic field. It is widely known that only parts of the body may be found in cases such as mass disasters, either natural or in situations of war, explosions and traffic accidents or acts of terrorism. Determination of stature and gender to establish identity in these cases becomes a challenging task (Kanchan et al., 2010).

Prediction of stature represents a vital factor to obtain the partial identification of an unknown body or separated limbs from the body (Jasuja and Singh, 2004), also determining gender of the body remains helps in decreasing the number of victims matches as it excludes half the population (Swami et al., 2013).

It is well-known that equations used for stature determination in one population could not be dependably applicable to another population. There would be errors in calculation of stature of the very tall or short individuals of the population (Duyar et al., 2006).

Consequently, previous studies on stature and gender estimation cannot be generalized to other populations due to genetic and environmental differences, so it becomes mandatory to have methods for stature and gender estimation to each ethnic group (Khan et al., 2016).

Several studies were done to determine stature and gender from hand length and foot length but only few studies were carried out on finger lengths. Although, a significant correlation of the middle finger length with the stature and gender was revealed (Koulapur et al., 2017).

In the present study an effort has been made to investigate the utility of middle finger length as a predictor of stature and gender.

Subjects and Methods

This cross-sectional study was carried out on medical students who attended the Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Ain Shams University. The study was authorized and approved by the local research ethics committee of the faculty of medicine, at Ain Shams University by ethical clearance (R138/2022). All participant students informally consented to participate in this study.

Inclusion criteria: The current study sample included 200 adult Egyptian students (100 males and 100 females) between 18 and 25 years old.

Exclusion criteria: Extremes of stature and those with any deformity including hand, axial skeleton, or lower limb.

Socio-demographic data including age and gender was collected.

Height measurement: Participants were asked to stand in an upright position barefooted, arms beside their thighs and heels in contact with each other. Shoulders, buttocks, and heels were in contact with the wall. The head was positioned in the Frankfort plane.

Stature (distance between the vertex and the floor) was measured.

Finger length measurements: The subjects sit comfortably in an upright position with their hands on a flat surface, the fingers had to be close to each other and extended, and the palm confronting upwards then with a Vernier caliper the middle finger length was measured from the proximal mid-point to the tip of the finger. Measurements were taken from the right and left sides.

For all participants, the same method was done. All measurements were taken in centimeters and by one observer to avoid bias, repeated three times and a mean value was taken.

Statistical analysis: The collected data statistically analyzed by using SPSS. Qualitative data was described by using number and percent. Quantitative data expressed as Mean and standard deviation. Independent t-test was used as a test of significance. Both linear regression analysis and Spearman correlation coefficients were used to study the relation between studied variants.

Results

The present study included 200 subjects, 100 of whom were males and 100 were females. The age of the studied students ranged from 18 to 25 years (20.96 ± 1.89 years) as shown in table (1) and figure (1).

Regarding the stature, it ranged from 150 to193 cm (mean± SD; 170.02 ±10.12 cm). The right middle finger length (R MFL) ranged from 6.5 to 9.5 cm (7.94 ± 0.56 cm). The left middle finger length (L MFL) ranged from 6.7 to 9.4cm (8.01 ± 0.53) (Table 2).

In females, the R MFL ranged from 6.5 to 8.7 cm (7.66 ± 0.47 cm) and the L MFL ranged from 6.7 to 8.7 cm (mean ± SD: 7.68 ±0.45cm). In males, the R MFL ranged from 7.2 to 9.5 cm (mean ± SD: 8.22 ± 0.50 cm) and the L MFL ranged from 7.7 to 9.4 cm (8.30 ± 0.42 cm). The MFL differed significantly for both males-females' values ($P<0.05$) in both hands. The average MFL was found to be greater in males than females (Table 3 and Figure 2).

There was positive correlation between MFL and stature in both males and females by using Spearman correlation coefficient (Table 4; figures 4-9).

The univariate linear regression analysis shows that there was statistically significant association found between stature and R MFL and L MFL. Also, the multivariate linear regression shows that the L MFL was found the most important predictor for stature (Table 5).

The equation for stature estimation from R MFL was:
Stature = 67.713+ (12.885 x R MFL) (Table 6)
The equation for stature estimation from LMFL was:
Stature = 57.508+ (14.192 x L MFL) (Table 7)

The calculated values in (Table 8) represent the threshold above which an individual is classified as male and vice versa. The most sensitive variable that differentiates between gender was L MFL 100% sensitivity and the most specific and accurate test (less false positive) was R MFL specificity 65%

ROC curves for prediction of male gender using: right MFL (AUC = 0.790, sensitivity = 83%, specificity = 65%); using left MFL (AUC = 0.840, sensitivity = 100%, specificity = 55.88%) (Figure 3)

Table 1: distribution of age and gender among studied subjects

		No.= 200
Age (years)	Mean±SD	20.96 ± 1.89
	Range	18 – 25
Gender	Female	100 (50.0%)
	Male	100 (50.0%)

SD: standard deviation

Table 2: Distribution of stature and middle finger length (MFL) of studied subjects

		No.= 200
Stature(cm)	Mean±SD	170.02 ± 10.12
	Range	150 – 193
R MFL (cm)	Mean±SD	7.94 ± 0.56
	Range	6.5 – 9.5
L MFL (cm)	Mean±SD	8.01 ± 0.53
	Range	6.7 – 9.4

SD: standard deviation; R MFL: right middle figure length; L MFL: left middle figure length

Table 3: Independent t-test statistical analysis to compare MFL in male and female studied subjects

		Gender		Test value•	P
		Female	Male		
		No.= 100	No.= 100		
R MFL (cm)	Mean±SD	7.66 ± 0.47	8.22 ± 0.50	-8.154	0.000***
	Range	6.5 – 8.7	7.2 – 9.5		
L MFL (cm)	Mean±SD	7.68 ± 0.45	8.30 ± 0.42	-8.593	0.000***
	Range	6.7 – 8.7	7.7 – 9.4		

*SD: standard deviation; R MFL: right middle figure length; L MFL: left middle figure length; P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant ****

Table 4: Spearman correlation coefficient between stature in relation to left and right MFL in male and female samples

	Stature					
	All Cases		Males		Females	
	r	P	r	P	r	P
R MFL	0.680	0.000***	0.628	0.000***	0.421	0.000***
L MFL	0.723	0.000***	0.606	0.000***	0.352	0.003***

*R MFL: right middle figure length; L MFL: left middle figure length; r: Spearman correlation coefficient; P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant ****

Table 5: Univariate and multivariate linear regression analysis of the studied subjects

	Univariate					Multivariate				
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	SE	Beta			B	SE	Beta		
(Constant)	67.713	7.115		9.517	0.000***	57.358	8.492		6.755	0.000***
R MFL (cm)	12.885	0.894	0.716	14.415	**0.000*****	-7.285	4.586	-0.391	-1.588	0.114*
(Constant)	57.508	8.536		6.737	0.000***					
L MFL (cm)	14.192	1.063	0.743	13.350	**0.000*****	21.470	4.702	1.123	4.566	**0.000*****

R MFL: right middle figure length; L MFL: left middle figure length; P-value > 0.05: Non significant; P-value < 0.05: Significant**; P-value < 0.01: Highly significant ****

Table 6: Regression Formula for stature estimation from RMFL in studied subjects

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	SE	Beta		
(Constant)	67.713	7.115		9.517	0.000***
R MFL(cm)	12.885	0.894	0.716	14.415	**0.000*****

*R MFL: right middle figure length; $Y=B_0+B_1x_1$, Y= 67.713+ (12.885*R MFL); SE: standard error*

Table 7: Regression Formula for stature estimation from LMFL in studied subjects

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	SE	Beta		
(Constant)	57.508	8.536		6.737	0.000***
L MFL(cm)	14.192	1.063	0.743	13.350	**0.000*****

*L MFL: left middle figure length; $Y=B_0+B_1x_1$, Y= 57.508+ (14.192*L MFL); SE: standard error*

Table 8: Sensitivity and specificity of R MFL and L MFL to identify male and female in studied subjects

Variable	Cut point	AUC	Sensitivity	Specificity	+PV	-PV
R MFL(cm)	>7.8	0.790	83.00	65.00	70.3	79.3
L MFL(cm)	>7.6	0.840	100.00	55.88	72.5	100.0

R MFL: right middle figure length; L MFL: left middle figure length

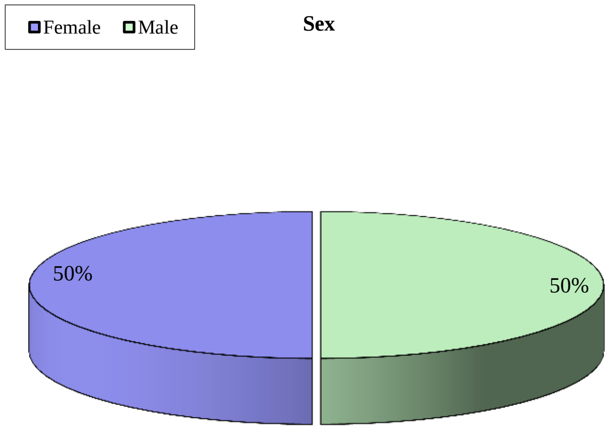

Figure1: Distribution of male/female ratio in the study

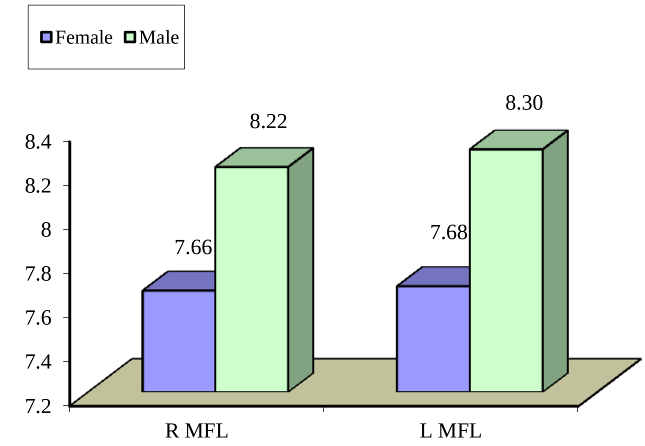

Figure 2: Distribution of RMFL and LMFL in males and females

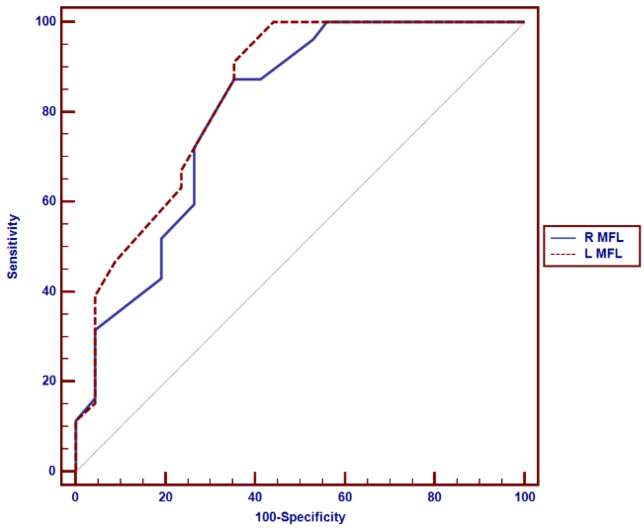

Figure 3: Sensitivity and specificity of R MFL and L MFL to identify male and female in studied subjects.

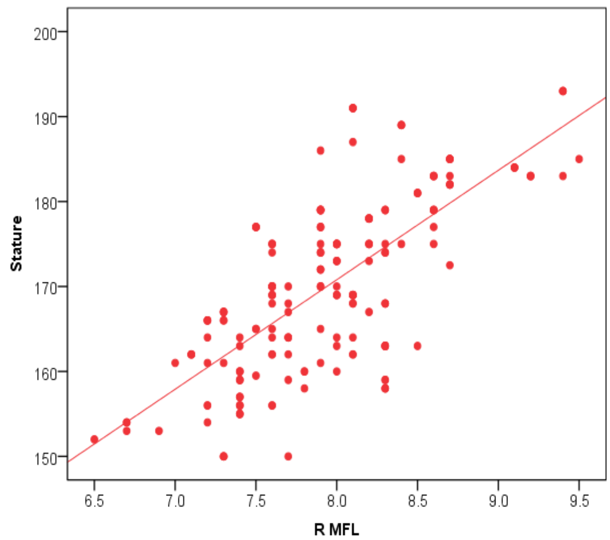

Figure 4: Correlation between stature and Right MFL in studied subjects

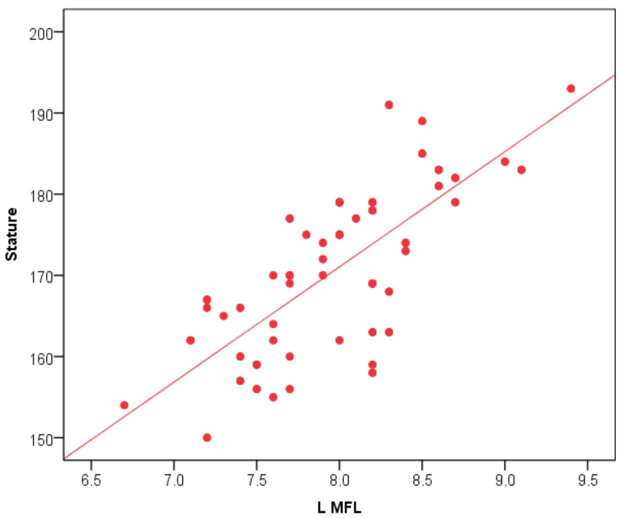

Figure 5: Correlation between stature and left MFL in studied subjects

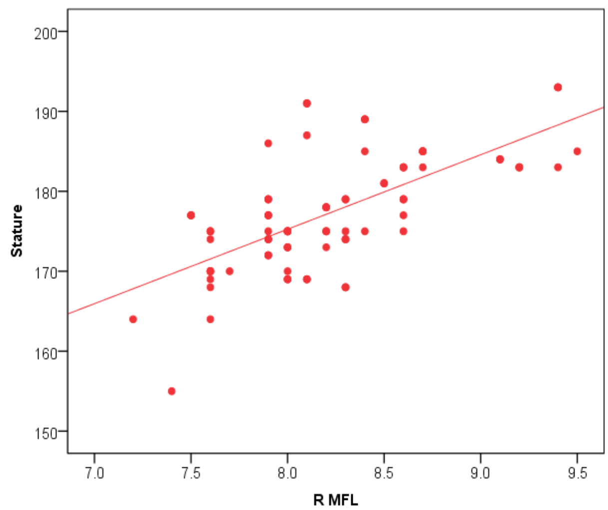

Figure 6: Correlation between stature and Right MFL in male studied subjects

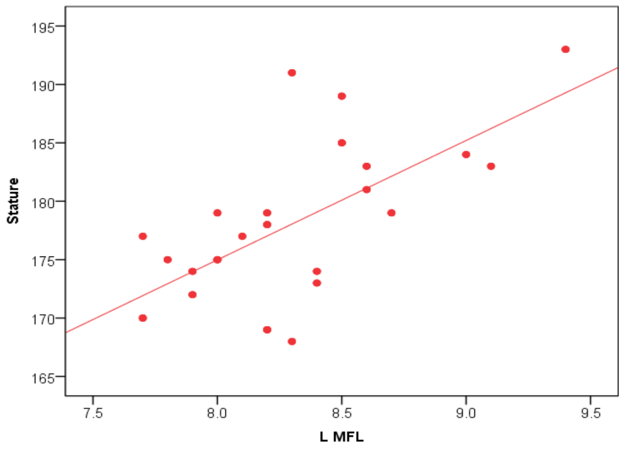

Figure 7: Correlation between stature and left MFL in male studied subjects

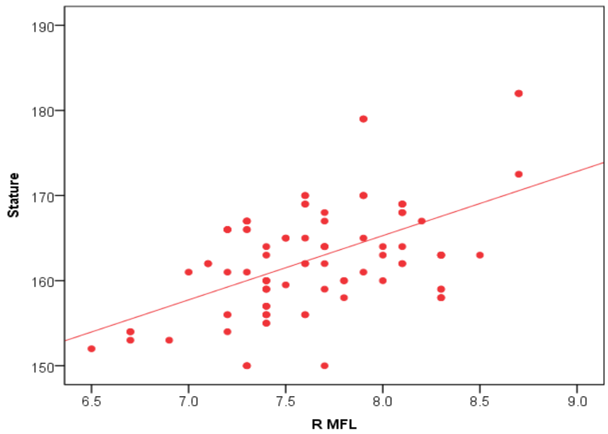

Figure 8: Correlation between stature and Right MFL in female studied subjects

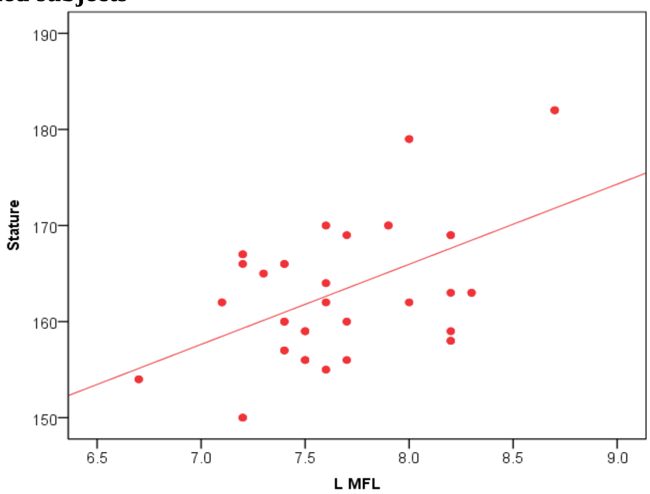

Figure 9: Correlation between stature and left MFL in female studied subjects

Discussion

Identification of human remains is a sophisticated part in medicolegal investigation. However, DNA technology is considered a good method in identification, but it has its limitations as regard financial issues and the need of a qualified technicians. In mass disasters, finding peripheral parts of the body is a frequent event. When an individual hand is found, measurements, radiological and osteological examination of the hand can be used to determine the main elements of identification as stature, age and gender (Aboul-Hagag et al., 2011).

Mathematical methods can be used for stature and gender estimation. Hence, formulas derived from regression analysis depending on hand dimensions are considered reliable tools for identification (Ali et al., 2022). However, those formulas are population specific (Agnihotri et al., 2008).

Although few studies have been conducted in Egypt (Habib and Kamal 2010; Paulis 2015, Sharaf El-Din et al., 2016), it is essential to highlight that the Egyptian population exceeds 100 million; they have wide population diversity due to wide variation in geographical regions and their specific characteristics; also due to variations in socio-economic, cultural, and environmental factors.

In the current study, the mean values of stature and length of middle finger in male subjects is higher than female subjects in both right and left hands, this is in agreement with other studies in Egypt (Ali et al., 2022 ; Paulis, 2015), India (Krishan and Sharma, 2007; Rastogi et al. 2008), Malaysia (Moorthy and Zulkifly, 2015), Turkey (Ozaslan et al., 2012), Sudan (Ahmed, 2013) and Saudi Arabia (Kornieieva and Elelemi, 2016). This can be explained by that the fusion of epiphyses is earlier in females than in males by two years (Ali et al., 2022).

In our study there was a positive correlation between the length of the middle finger and estimation of stature for both males and females. This is in agreement with Katwal et al. (2017) who found a strong relation between middle finger length and stature in males and females among a group of Nepalese population. Also Ahuja et al. (2018) in their study for estimation of stature from different fingers concluded that middle finger is more reliable for the estimation of stature. Moreover, Rastogi et al. (2008), Rhiu and Kim (2019) and Verghese et al. (2010) found that middle finger length can be considered as an important method for determination of height in both genders.

In another study by Shivakumar et al. (2011), they confirmed that middle finger length is strongly correlated with stature in people of Karnataka region in south India.

Koulapur et al. (2017) in the study performed in North Karnataka region of India reported a strong relationship between MFL and stature in both genders, but the equations in our research are distinctive from their study.

The regression equation obtained in the present study for all cases is:

1) Stature = 57.508+ (14.192 x L MFL)
2) Stature = 67.713+ (12.885 x R MFL)

That in comparison with Koulapur et al. (2017) the equation was:

1) Stature= 81.187+(11,188 x LMFL)
2) Stature= 80.612+ (11.272 x RMFL)

In a study performed in Egypt by Ali et al. (2022) it was evident that stature was significantly correlated in both genders to hand dimensions; this study was performed in Ismailia and they recommend further studies of other geographical regions in Egypt in order to have a biological specific Egyptian Standard.

Gender determination is considered a main step in the identification of an individual especially in mass disasters and in ethnic studies by a forensic investigator. Sexual dimorphism can be determined by the length of fingers so anthropometric measurements of the hand small bone become a precious method for gender determination (Abd-Elazeem and Yousef, 2013)

As regard gender determination in our study, the middle finger is longer in males than in females. Morphological gender differences in fingers length have been illustrated in different studies as in Aboul Hagag et al. (2011), Habib and Kamal (2010) and Kanchan et al. (2010). The mean of middle finger length in the present study was 7.66 ± 0.47 in RMF in females and 8.22 ± 0.50 in males while the mean in LMF in females was 7.68 ± 0.45 and in males was 8.30 ± 0.42 that in comparison with Iroanya et al. (2020) in which the mean values were RMF 7.48±0.65 in females and 8.1 ± 0.64 in males while LMF 7.5 ± 0.67 in females and 8.17±0.67 in males and this slight variation can be attributed to influence of population and ethnic variability.

In Hafez and Shahin (2021) study, they found that finger length is a good discriminator of gender and it is superior to fingers ratio or hand index.

Identification of gender in the present study by middle finger length was evaluated by ROC curve analysis and determination of the AUC. A cut off point > 7.8 in right hand and > 7.6 in left hand were indicative of males while a cutoff point ≤ 7.8 in right hand and ≤ 7.6 in left hand is indicative of females.

These are in partial agreement with previous studies as Abd-Elazeem and Yousef (2013) in which they concluded that the study of fingers length could help in gender determination among Egyptian populations and they reported that left middle finger was the most accurate and specific with 83% specificity and 79% sensitivity, while right middle finger with specificity 69% and sensitivity 78%. These values are different from our study results in which left middle finger specificity 55.88% and sensitivity 100% while right middle finger with specificity 65% and sensitivity 83%.

Although the extent of variability between studies and population groups in gender determination from finger length, our research confirms the observations of others that finger length can be a predictor of gender.

Conclusion

In the current study, the length of middle finger was found as an effective tool in determination of stature in both genders, regression equations were obtained to assess stature from length of middle finger, also we found that middle finger length can be utilized as an indicator of gender.

Recommendations

Further studies using larger sample size in different areas in Egypt are mandatory in order to validate the utilization of middle finger length in gender and stature determination for forensic investigations.

References

Abd-Elazeem GM and Yousef W (2013): Sex Determination using Finger Length, Fingers Ratio, and Foot Dimensions in Fayoum Governorate. Ain Shams Journal of Forensic Medicine and Clinical Toxicology, 21:12-19.

Aboul-Hagag, KE, Mohamed SA, Hilal MA and Mohamed EA (2011): Determination of sex from hand dimensions and index/ring finger length ratio in Upper Egyptians. Egypt Journal of Forensic Sciences, 1(2): 80-86.

Agnihotri AK, Agnihotri S, Jeebun N, and Googoolye K (2008): Prediction of stature using hand dimensions. Journal of Forensic and Legal Medicine, 15(8): 479-482.

Ahmed AA (2013): Estimation of stature from the upper limb measurements of Sudanese adults. Forensic Science International; 228(1-3): 178.e1-7.

Ahuja P, Manve P, Gloria Christal G and Dahiya MS (2018): Estimation of Stature from Finger Length. Journal of Forensic Sciences & Criminal Investigation, 7(2):1-4.

Ali SM, Hashish RK, Abdel-Karim RI, Dessouki SK and El–Dabeh SY (2022): Use of hand and its corresponding print dimensions in stature estimation. The Egyptian Journal of Forensic Sciences and Applied Toxicology, 22 (1):81-94.

Duyar I, Pelin C, Zagyapan R (2006): A new method of stature estimation for forensic anthropological application. Anthropological Science, 114(1):23-7.

Habib SR and Kamal NN (2010): Stature estimation from hand and phalanges lengths of Egyptians. Journal of Forensic and Legal Medicine, 17(3): 156-160.

Hafez ASAF and Shahin MM (2021): Study of Hand and Finger Indices for Prediction of Sex and Estimation of Stature in a Sample of Egyptian and Malaysian Youth. Mansoura Journal of Forensic Medicine and Clinical Toxicology, 29(1):63-80.

Iroanya O, Egwuatu TF, Talabi OT and Ogunleye LS (2020): Sex Prediction Using Finger, Hand and Foot Measurements for Forensic Identification in a Nigerian Population. Sakarya University Journal of Science, 24(3):432-445.

Jasuja O and Singh G (2004): Estimation of stature from hand and phalange length. JIAMF, 26(3):971–3.

Kanchan T, Krishan K, Sharma A and Menezes R (2010): A study of correlation of hand and foot dimensions for personal identification in mass disasters. Forensic Science International, 199(1-3): 112.e1–6.

Katwal B, Panta P, Pandit R and Shrestha N (2017): Estimation of stature from length of middle finger among nepalese medical student of Nepal Medical College and Teaching Hospital. Med Pulse International Journal of Forensic Medicine, 3(1): 1-4.

Khan F, Vaswani VR, Pramod KL, Badiadka KK (2016): Estimation of stature from middle finger length among college students in Mangalore. International Journal of Recent Trends in Science and Technology, 18(3):384-387.

Kornieieva M and Elelemi AH (2016): Estimation of Stature from Hand Measurements and Handprints in a Sample of Saudi Population. Arab Journal of Forensic Sciences & Forensic Medicine, 1(3):289-298.

Koulapur V, Sekhar BC, Porwal R, Ali K, Honnungar RS and Pujar SS (2017): Estimation of stature from middle finger length. International Journal of Forensic Medicine and Toxicological Sciences, 2(1):8-12.

Krishan K and Sharma A (2007): Estimation of stature from dimensions of hands and feet in a North Indian population. Journal of Forensic and Legal Medicine, 14(6):327–332.

Moorthy TN and Zulkifly NR (2015): Regression analysis for stature determination from the hand anthropometry of Malaysian Malays for forensic investigation. Sri Lanka Journal of Forensic Medicine, Science & Law, 5(2):8-15.

Ozaslan A, Karadayi B, Kolusayin MO, Kaya A, and Afsin H. (2012): Predictive role of hand and foot dimensions in stature estimation. Romanian Journal of Legal Medicine, 20(1): 41-46.

Paulis MG (2015): Estimation of stature from handprint dimensions in Egyptian Population. Journal of Forensic and Legal Medicine, 34:55-61.

Rastogi P, Nagesh KR and Yoganarasimha K (2008): Estimation of stature from hand dimensions of north and south Indians. Legal Medicine, 10(4):185-189.

Rhiu I and Kim W (2019): Estimation of stature from finger and phalange lengths in a Korean adolescent. Journal of Physiological Anthropology, 38(1):1-8.

Sharaf El-Din A, Elkholy S, and Yousef M. (2016): Prediction of stature based on upper limb measurements among Egyptian population. Eur J Forensic Sci;3(2):1-7

Shivakumar AH, Vijaynath V and Raju GM (2011): Estimation of co-relation between middle finger length & stature of females in south indian population. Indian Journal of Forensic Medicine and Toxicology 5(1):75-76.

Swami, S, Kumar, T, Sharma, D et al. (2013): ‘‘Effect of hand preference on second to fourth digit ratio and its role in sexual dimorphism: A study in 300 Haryanvi brahmins and 300 Kashmiri Pandits’’. Eur. J. Anat., 17: 243-249.

Verghese AJ, Balaraj BM, Pramod Kumar GN (2010): A study of estimation of stature from length of fingers in Mysore. Indian Journal of Forensic Medicine and Toxicology, 4(2):12-13.

طول الأصبع الأوسط كمؤشر لتحديد طول القامة والجنس فى عينة من طلاب الطب المصريين بكلية الطب جامعة عين شمس

نهى فريد دياب و ولاء طلعت توفيق [1]

الملخص العربى

المقدمة: الاستعراف هو أحد الأركان الأساسية في تحقيقات الطب الشرعي ويمثل تحديد طول القامه معيارًا حيويًا للوصول إلى الاستعراف الجزئي لجسم مجهول الهوية, وعلاوة على ذلك فان تحديد الجنس يستطيع استبعاد نصف السكان .**الهدف من الدراسة:** تقييم طول الإصبع الأوسط كمؤشر لتحديد طول القامة والجنس.**طريقة البحث:** تم إجراء هذه الدراسة المقطعية في قسم الطب الشرعي والسموم الإكلينيكية بكلية الطب جامعة عين شمس بعد الحصول على الموافقة الأخلاقية من لجنة الأخلاقيات. تم جمع بيانات عن العمر والجنس والطول وطول الإصبع الأوسط .**النتائج:** بلغ العدد الإجمالي للمشاركين في هذه الدراسة ٢٠٠ (١٠٠ ذكر و ١٠٠ أنثى) تتراوح أعمارهم بين ١٨ و ٢٥ سنة. كانت هناك علاقة ارتباط موجبة بين طول الاصبع الأوسط وطول القامة في كل من الذكور والإناث. اما بالنسبة لتحديد الجنس كان المتغير الأكثر حساسية هو طول الأصبع الأوسط الأيسر(١٠٠٪) وكان المتغير الأكثر دقة والأقل فى الإيجابية الكاذبة هو طول الأصبع الأوسط الأيمن (٦٥%). **الخلاصة:** دراسة طول الأصبع الأوسط يمكن أن تساعد في تحديد طول القامة والجنس بين السكان المصريين.

١. قسم الطب الشرعي والسموم، كلية الطب، جامعة عين شمس، القاهرة، جمهوريه مصر العربية