Int. J. Morphol.,
42(3):850-854, 2024.

Biometrics of the Hand's Middle Finger to Determine Stature in Chilean University Students

Biometría del Dedo Medio de la Mano para Determinar Estatura en Estudiantes Universitarios Chilenos

Carvallo, P.[1]; Salazar-Fernández, C.[2] & Batlle, C.[3]

CARVALLO, P.; SALAZAR-FERNÁNDEZ, C. & BATLLE, C. Biometrics of the hand's middle finger to determine stature in Chilean university students. *Int. J. Morphol., 42(3)*:850-854, 2024.

SUMMARY: Biometrics and forensic osteology play a significant role in human identification, as the morphological uniqueness of every individual enables the differentiation and recognition of skeletal remains. Through meticulous analysis of human remains, it is possible to determine key demographic attributes such as stature, a significant parameter in the forensic identification process. This information is of practical relevance for the identification of individuals in contexts such as disasters, vehicular accidents, terrorist attacks, armed conflicts, and forensic investigations. The objective of this study was to determine the correlation between the hand's middle finger length and stature in a group of Chilean students. A total of 211 students of both sexes from La Araucanía region, Chile, participated in the study. After obtaining informed consent to participate voluntarily in the study, each individual underwent a general anthropometric examination, followed by a specific assessment of the length of the middle finger (MFL) of both hands. The results of the multiple linear regression analysis indicated a significant prediction of stature using the length of the right (R-MFL) and left (L-MFL) middle fingers, $F(2, 207) = 79.80$, $p < 0.001$. The equations for estimating stature based on the length of the middle fingers are as follows: for R-MFL, Stature = 91.265 + (8.092 × R-MFL), and for L-MFL, Stature = 83.967 + (8.889 × L-MF). Based on these results, it was found that the length of the middle finger of both hands is predictive of stature.

KEY WORDS: Stature; Middle finger length; Biometrics; Identification.

INTRODUCTION

Forensic osteology plays a significant role in human identification, as the morphological uniqueness of every individual enables the differentiation and recognition of skeletal remains. Through meticulous analysis of skeletal remains, it is possible to determine key demographic attributes such as race, sex, stature, and age, which are significant parameters in the forensic identification process (Sheuer, 2002).

In a study conducted in Egypt, Diab & Tawfik (2023) found that the length of the middle finger can be used as an indicator of stature and sex. This result is consistent with previous research that has shown a significant correlation between middle finger length and stature (Koulapur *et al*., 2017). Similarly, studies in India have estimated stature based on measurements of the length of the foot or long bones (Haque *et al*., 2023). However, these estimations of stature are only applicable to these specific ethnic groups due to the inherent genetic variations and environmental factors that may be associated with the morphometric characteristics of the different populations (Khan *et al*., 2016).

According to Cardoso *et al*. (2014), the optimal age range for establishing predictive relationships between stature and finger length is between 18 and 25 years. During this period, maximum stature is reached due to the fusion of most of the secondary ossification centers.

Considering the limited research of this nature in Chileans or Latin Americans in general, the objective of this study was to determine the potential association between middle finger length and stature in Chilean university students. This information is of practical relevance for the identification of persons in disasters, vehicular accidents, terrorist attacks, and forensic investigations.

[1] Carrera de Psicología, Facultad de Ciencias Sociales y Humanidades, Universidad Autónoma de Chile, sede Temuco, Temuco, Chile.
[2] Doctorado en Psicología, Departamento de Psicología, Universidad de La Frontera, Temuco, Chile,
[3] Facultad de Medicina, Universidad de La Frontera, Temuco, Chile.

Received: 2023-12-19 Accepted: 2024-02-10

MATERIAL AND METHOD

This cross-sectional correlational study was conducted with university students from La Araucanía region, Chile, during the second semester of the year 2023, following prior authorization and approval by the Scientific Ethics Committee of the Universidad Autónoma de Chile (code 42-23) and adhering to the guidelines of the Helsinki declaration for studies on human subjects. The methodological design follows the guidelines of the AQUA checklist for anatomical studies (Tomaszewski *et al*., 2017).

211 university students selected through non-probabilistic convenience sampling participated in the study. The sample size is similar to the study conducted by Diab & Tawfik (2023) and Haque *et al*. (2023). After obtaining informed consent to participate voluntarily in the study, each individual underwent a general anthropometric examination, followed by a specific assessment of the length of the middle finger of both hands. Participants were classified as female or male based on biological characteristics.

Inclusion criteria were: age between 18 and 25 years, Chilean nationality. Exclusion criteria were: extreme statures, chronic diseases, diseases affecting bone tissue and stature, hormonal conditions affecting stature and growth.

The measurement of the length of the middle finger of the hand was taken from the dorsal side of the metacarpophalangeal joint to the distal end of the finger. A Mitutoyo® calyper with an accuracy of 0.05 mm was used to record the measurements. All measurements were taken in centimeters by the same observer and repeated three times to obtain an average.

To measure stature, the distance between the vertex and the platform of the SECA213® mechanical stadiometer was used. Participants stood barefoot with their arms at the sides of the thighs and with their heels together. The head was positioned without any strain in the Frankfort plane, i.e., the tragion and the infraorbital margin must lie in the same plane. Measurements were taken in centimeters by the same researcher, at a fixed time between 9:30 and 12:00 h, to eliminate diurnal variation in stature.

Statistical Analysis

The data was processed using the Jamovi software (Jamovi Project, 2021). Frequency and descriptive analyses were conducted for the entire dataset, with separate analyses conducted for female and male participants. The assumptions of normality and homogeneity of variances were also examined. To identify differences between sexes, independent t-tests and Cohen's d was used. Cohen's d is employed to quantify the magnitude of the difference between two groups, with larger values indicating a more pronounced distinction. As proposed by Cohen (2013), values exceeding 0.8 denote a large effect size. Additionally, Spearman correlations were used to analyze the relationship between stature and hand measurements. Lastly, both univariate and multiple linear regressions were used to evaluate the prediction of stature based on the length of the hands' right and left middle fingers.

RESULTS

In the study, there were 211 participants, comprising 143 females (67.7 %) and 68 males (32.22 %). Participants' statures varied between 162 and 186 cm, while weight ranged from 54.9 to 135 kg (Table I). Right middle finger length (R-MFL) ranged between 7.73 and 10.6 cm, whereas left middle finger length (L-MFL) was between 7.85 and 10.8 cm. Table I displays the mean and standard deviation for the entire sample and stratified by sex. Assumptions of normality and homogeneity of variances were confirmed ($p > 0.05$). T-tests revealed statistically significant differences in R-MFL and L-MFL between males and females ($p's < 0.05$). Males exhibited a higher average MFL compared to females (Fig. 1). Furthermore, Cohen's d revealed values exceeding 0.8, indicating a large effect size for these observed differences.

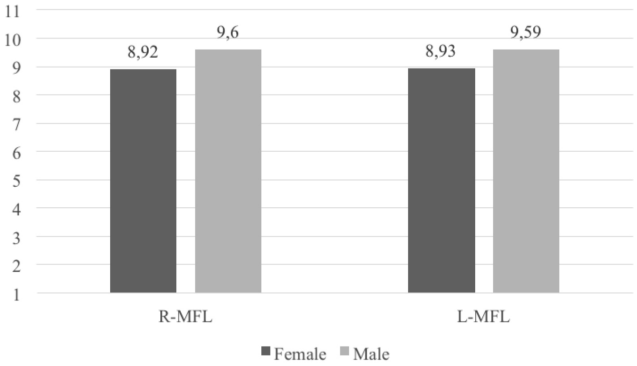

Fig. 1. Means of Middle Finger Lengths (Right and Left Hands) in females and males. R-MFL = Right Middle Finger Length, L-MFL = Left Middle Finger Length.

A statistically significant and positive correlation was observed between stature and MFL in both the overall sample and the individual male and female groups, as determined by the Spearman coefficient (Table II).

The univariate linear regression analysis, presented in Table III, revealed a statistically significant association between stature and both R-MFL ($F(1, 208) = 146.00$, $p < 0.001$) and L-MFL ($F(1, 209) = 139.100$, $p < 0.001$). These

models accounted for 39.7 % and 40.9 % of the stature variance, respectively.

The results from the multiple linear regression analysis indicated a significant prediction of stature using both right and left MFL, $F(2, 207) = 79.80$, $p < 0.001$. This model explained approximately 43 % of the variance in stature ($R2 = 0.435$, Adjusted $R2 = 0.430$). Both L-MFL and R-MFL demonstrated predictive value for stature, as shown by the standardized coefficients in Table III. Additionally, statistical analysis reveals no significant difference between the predictive capabilities of L-MFL and R-MFL ($t(414) = 0.036$, $p = 0.970$), confirming both as adequate predictors of stature. The equations to estimate stature based on finger lengths are as follows: For R-MFL, Stature = 81.970 + (9.100 x R-MFL), and for L-MFL, Stature = 83.970 + (8.889 x L-MF).

Table II. Spearman correlation coefficient between stature middle finger lengths (right and left hands) in female and male.

	Stature		
	Total sample	Females	Males
R - MFL (cm)	.630*	.367*	.542*
L – MFL (cm)	.606*	.356*	.491*

Note. R-MFL = Right middle finger length, L-MFL = left middle finger length.

Table I. Means and Standard Deviations for stature, weight, and middle finger lengths (right and left hands).

	Total sample, $n = 211$	Females $n = 143$	Males $n = 68$	Test value	Cohen´s *d*
Stature (cm)	165.0 (8.05)	161.00 (5.67)	173.00 (6.07)	-	-
Weight (kg)	71.6 (16.0)	69.80 (16.8)	75.6 (13.2)	-	-
R-MFL (cm)	9.14 (0.609)	8.92 (0.535)	9.60 (0.484)	8.91 (208)*	1.31
L-MFL (cm)	9.14 (0.572)	8.93 (0.467)	9.59 (0.513)	9.34 (209)*	1.38

Note. * $p < 0.05$. R-MFL = Right middle finger length, L-MFL = Left middle finger length.

Table III. Regression coefficients for stature estimation from left and right MFL in the total sample.

	Unstandardized coefficients		Standardized coefficients	*t*	*p*	95% Confidence interval
	Estimate	SE				
Univariate linear regression R-MFL						
Constant	91.265	6.658	-	13.708	-	-
MFL – R (cm)	8.092	0.727	0.611	11.138	< 0.001	0.503, 0.719
Univariate linear regression L-MFL						
Constant	83.967	6.903	-	12.164	-	-
L-MFL (cm)	8.889	0.754	0.632	11.796	< 0.001	0.527, 0.738
Multiple linear regression						
Constant	79.438	6.949	-	11.43	< 0.001	-
R-MFL (cm)	3.770	1.217	0.285	3.097	0.002	0.103, 0.466
L-MFL (cm)	5.615	1.296	0.398	4.333	< 0.001	0.217, 0.580

Note. R-MFL = Right middle finger length, L-MFL = Left middle finger length.

DISCUSSION

The results of this study showed that, for a sample of Chilean university students, the length of the middle finger of both hands can be associated with stature and be used as a predictor of it. The results of the multiple linear regression analysis indicated a significant prediction of stature using the length of the right and left middle fingers.

These results are consistent with research by Koulapur *et al*. (2017), Waghmare *et al*. (2019), and Diab & Tawfik (2023), who also reported a significant correlation between middle finger length (MFL) and stature. This consistency holds despite the genetic and environmental differences between the populations studied, considering that these previous investigations were conducted in India (Koulapur *et al*., 2017) and Egipt (Waghmare *et al*., 2019).

In particular, in the study by Koulapur *et al*. (2017), the following regression equations were obtained: Stature= 81.187 + (11.188 x L-MFL) and Stature= 80.612 + (11.272 x R-MFL). On the other hand, Waghmare *et al*. (2019) differentiated their results by sex, finding the following equations for women: Stature = 114.18 + (5.589 × R-MFL)

and Stature = 114.10 + (5.621 × L-MFL), and the following for men: 118.7 + (6.443 × R-MFL) and 118.56 +(6.473 × L-MFL. Moreover, Diab & Tawfik (2023) in Egypt adopted a different approach by measuring the middle finger from the palmar digital crease to the fingertip in a group of 200 students aged 18 to 25 years. Their results, which also revealed a statistically significant relationship between MFL and stature, indicated that the length of the left middle finger (L-MFL) was a better predictor of stature than the length of the right middle finger (R-MFL), thus aligning with the results of the present study. These similarities reinforce the validity of the use of MFL as a reliable indicator of stature, regardless of the differences between populations.

The results of the present study provide valuable information that complements the available data in Chile on the relationship between MFL and height. To date, only the study by Binvignat *et al*. (2012) conducted in Maule region has explored this relationship. That study, which included a sample aged 18 to 69 years, revealed that the average stature was 1.65 cm in women and 1.70 cm in men, with an average MFL of 100.4 mm in the right hand and 99.2 mm in the left hand in women, and 115 mm and 114.6 mm, respectively, in men. These results, which show a longer MFL than those obtained in the present study, may be attributed to differences in the ethnic composition of the regions studied.

In our study, conducted in La Araucanía region, 34.3 % of the population identifies as belonging to an indigenous or native people (Instituto Nacional de Estadísticas, 2019), and in our specific sample, 30.3 % identified as Mapuche. Bearing this in mind, an average stature of 1.61 cm in women and 1.73 cm in men was found, with an MFL of 8.92 cm in the right hand and 8.93 cm in the left hand in women, and 9.60 cm and 9.59 cm, respectively, in men. These results, when contrasted with those obtained by Binvignat *et al*. (2012) emphasize the importance of considering ethnic variability within the same country, broadening our understanding of biological diversity and its impact on anthropometric parameters such as stature and MFL.

Research on the analysis of middle finger length and stature is crucial, especially in contexts where accurate identification is challenging, such as in catastrophic accidents, missing person cases, armed conflicts, forensic investigations, and archaeological studies, among others. In such situations, usually limited human remains are encountered, and biometrics and osteology emerge as vital tools for determining personal characteristics, such as stature, from specific bone fragments.

The study of stature from skeletal remains, especially long bones, is considered a direct and reliable parameter in adults (Sheuer, 2002). However, this approach requires detailed, population-specific databases due to the variability in skeletal morphological characteristics throughout life and the influence of genetic, environmental, nutritional, hormonal, and socioeconomic factors on stature (Kahn *et al*.). These factors vary among different ethnicities and geographic regions, as evidenced by the differences observed between the studied samples from India and Egypt.

This study contributes to the scientific literature by providing valuable information on La Araucanía region, complementing the limited available data in Chile and laying a foundation for future research in forensic identification. By better understanding how middle finger length relates to stature in different populations, more accurate and accessible methods for the identification of human remains can be developed. This is particularly relevant in situations where traditional techniques are not viable, either because of their cost or the requirement for highly trained personnel.

Finally, it is important to highlight as a strength of this study the use of the Mitutoyo® measuring instrument, identical to that used by Binvignat *et al*. (2012). This consistency in the equipment used guarantees greater reliability and comparability of results, especially when considering the Chilean population. Unlike Diab & Tawfik (2023) study, in our research, we measured the total length of the middle finger, extending from the metacarpophalangeal joint to the fingertip, instead of measuring from the palmar digital crease to the tip. This measurement strategy provides greater accuracy in measurements by considering the total length of the finger.

Despite the above, the study has some limitations. The main weakness lies in the fact that only middle finger length and stature were explored, without assessing differences according to sex. This was because the proportion of women (n = 143) in the sample was greater than that of men (n = 68), limiting the possibility of examining this association. Future research should focus on expanding and balancing the sample in terms of sex to explore this relationship, as well as considering other important sociodemographic variables such as age and ethnicity.

CONCLUSION

The information provided in this study allows for predicting the stature of Chilean individuals from La Araucanía region based on the length of the middle finger of both hands. It is necessary to extend this study to other regions of the country to achieve a characterization of our population that validates the use of middle finger length to determine stature in forensic investigations.

CARVALLO, P.; SALAZAR-FERNÁNDEZ, C. & BATLLE, C. Biometría del dedo medio de la mano para determinar estatura en estudiantes universitarios chilenos. *Int. J.Morphol., 42(3)*: 850-854, 2024.

RESUMEN: La biometría y la osteología forense desempeñan un papel relevante en la identificación humana, dado que la singularidad morfológica de cada individuo permite la diferenciación y reconocimiento de restos óseos. Mediante el análisis meticuloso de los restos humanos, es posible determinar atributos demográficos clave como la estatura, un parámetro significativo en el proceso de identificación forense. Esta información posee relevancia práctica para la identificación de personas en contextos de desastres, accidentes vehiculares, ataques terroristas, conflictos armados e investigaciones forenses. El objetivo de este estudio fue determinar la correlación entre la longitud del dedo medio de la mano con la estatura, en un grupo de estudiantes chilenos. Se evaluaron 211 estudiantes de ambos sexos de la región de La Araucanía, Chile. Tras obtener el consentimiento informado para participar voluntariamente en el estudio, se sometió a cada individuo a un examen antropométrico general, seguido de una evaluación específica de la longitud del dedo medio (MFL) de ambas manos. Los resultados del análisis de las regresiones lineales múltiples indicaron una significativa predicción de estatura utilizando la longitud de los dedos medios derecho (R-MFL) e izquierdo (L-MFL), $F(2, 207) = 79.80$, $p < 0.001$. Las ecuaciones para estimar estatura basados en la longitud de los dedos medios son las siguientes: para R-MFL, Stature = 91.265 + (8.092 × R-MFL) y para L-MFL, Stature = 83.967 + (8.889 × L-MF). A partir de estos resultados, se encontró que la longitud del dedo medio de ambos manos es predictora de estatura.

PALABRAS CLAVE: estatura, longitud dedo medio, biometría, identificación.

REFERENCES

Binvignat, O.; Almagià, A.; Lizana, P. & Olave, E. Biometric aspects of the hand in chilean individuals. *Int. J. Morphol., 30(2)*:599-606, 2012.

Cardoso, H. F.; Pereira, V. & Rios, L. Chronology of fusion of the primary and secondary ossification centers in the human sacrum and age estimation in child and adolescent skeletons. *Am. J. Phys. Anthropol., 153(2)*:214-25, 2014.

Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. Cambridge, Academic Press, 2013.

Diab, N. F. & Tawfik, W. T. Middle Finger Length: a predictor of stature and gender in a sample of Egyptian medical students - Faculty of Medicine-Ain Shams University. *Ain Shams J. Forensic Med. Clin. Toxicol., 40*:52-8, 2023.

Haque, A.; Singh, A. K.; Kumari, R.; Kumari, M.; Alam, J.; Raj, P. & Akhtar, J. Estimation of stature from the measurement of hand and foot in the population of Nalanda district of Bihar. *Int. J. Acad. Med. Pharm., 5(1)*:724-9, 2023.

Instituto Nacional de Estadísticas. *Síntesis de resultados Censo 2017: Región de La Araucanía.* Santiago de Chile, Instituto Nacional de Estadísticas, 2019. Available from: https://regiones.ine.cl/documentos/default-source/region-ix/estadisticas-r9/publicaciones-anuales-enfoques-y-minutas/ediciones-especiales/2019/s %C3 %ADntesis-de-resultados-censo-2017-la-araucan %C3 %ADa.pdf?sfvrsn=40bae9b8_6

Khan, F.; Vaswani, V. R.; Pramod, K. L. & Badiadka, K. K. Estimation of stature from middle finger among college students in Mangalore. I*nt. J. Recent Trends Sci. Technol., 18(3)*:384-7, 2016.

Koulapur, V.; Sekhar, B. C.; Porwal, R.; Ali, K.; Honnungar, R. S. & Pujar, S. S. Estimation of stature from middle finger length. *Int. J. Forensic Med. Toxicol. Sci., 2(1)*:8-12, 2017.

Mittal, M.; Gupta, P.; Kalra, S.; Bantwal, G. & Garg, M. K. Short stature: understanding the stature of ethnicity in height determination. *Indian J. Endocrinol. Metab., 25(5)*:381-8, 2021.

Sheuer, L. Application of osteology to forensic medicine. *Clin. Anat., 15(4)*:297-312, 2002.

The Jamovi Project. *Computer Software*. Jamovi, Version 2.2., 2021. Available from: https://www.jamovi.org

Tomaszewski, K. A.; Henry, B. M.; Ramakrishnan, P. K.; Roy, J.; Vikse, J.; Loukas, M.; Tubbs, R. S. & Walocha, J. A. Development of the Anatomical Quality Assurance (AQUA) Checklist: Guidelines for reporting original anatomical studies. *Clin. Anat., 30(1)*:14-20, 2017.

Waghmare, S. S.; Pawar, V. G. & Kachare, R. V. Utility of middle finger length in stature estimation among Maharashtrian students at S. R. T. R. Government Medical College, Ambajogai, Dist. Beed, in Maharashtra, India. *Int. J. Forensic Med. Toxicol. Sci., 4(2)*:34-8, 2019.

Dirección para Correspondencia:
Prof. Dr. Pamela Carvallo Semler
Universidad Autónoma de Chile
Temuco
CHILE

E-mail: pamela.carvallo@uautonoma.cl