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**Original Article**

# Correlation between Body Height, Percutaneous Foot and Forearm Lengths in Adult Egyptians

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## ABSTRACT

**Background:** Many studies related the total body height to lengths of different body segments. To our knowledge, no correlation between lengths of foot and forearm, and the total body height is available. The aim of the present study is to correlate these three parameters and to derive regression formulae to estimate the living total body height from the percutaneous foot and forearm lengths.

**Material and Methods:** 1000 Egyptian medical students shared in the study (500 males and 500 females) with age range (17-23 years). Total body height in the standing position, foot length, and forearm length were measured. All measurements were analyzed statistically, and a regression formula was created to calculate total body height by using foot and forearm lengths among the studied subjects according to their sex. Also, the intraclass correlation (ICC) was built up to correlate between the foot and forearm lengths among the studied subjects and by their sex.

**Results:** It was found that there was a positive correlation between total body height and lengths of foot and forearm. The correlation was higher with foot length (r = +0.69) than forearm length (r = +0.67). The correlation was higher in females. Linear regression analysis and regression formulae were created for the association between total body height and foot and forearm lengths in both sexes. There was a significant agreement between the foot and forearm lengths with a higher intraclass correlation coefficient (ICC) in females (0.70) than males (0.32).

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**Key Words:** Foot length, forearm length, total body height.

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## INTRODUCTION

Body height is one of the most important elements of identification of individuals.[1] As body height is often difficult to be quantified, alternative anthropometric measurements as arm-span[2], hand dimensions[3], knee height[4] and ulnar length[5] were used to estimate it.

Total Body Height (TBH) is an essential clinical measurement that helps to calculate body mass index, body surface area, and pulmonary function. These measurements help to adjust drug dosages and nutritional requirements.[6,7] Estimation of the standing TBH by using other body measurements is helpful in some clinical cases where the standing TBH cannot be measured accurately in disabled patients, elderly people and emergency and critically ill patients.[8] TBH of an individual is affected by various factors such as race, gender, and nutrition.[9]

Medico-legally, TBH is helpful in establishing the physical identity of an individual from mutilated, decomposed and amputated body fragments as in disasters, terror attacks and wars.[10] Anatomists, anthropologists, medico-legists, and artists have been for a long time interested in assessing dimensional relationships between the body segments and the whole body. Ancient Egyptians were the earliest to use such rules. An established relationship between stature and various body parts like head, trunk, upper and lower extremities were found.[10-13]

Different anthropometric measurements were correlated with height such as ulnar length[14, 15], knee height[16-18], hand dimensions[10,19],

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metacarpal bones[20] dem-ispan and arm span[1, 21-28], vertebral column[29], sternum[30], hand and foot[31] and cephalo-facial dimensions.[32] This correlation was found to be ethnic-specific, sex and age-dependent.[1, 22, 33]

TBH could be more accurately estimated from foot measurement.[12, 13, 33-36] This is particularly useful in adolescents, as compared to that from long bones as ossification and maturation in the foot occurs earlier than the long bones.[37] Forearm length[38, 39] particularly ulnar length[27, 40-42] was found to be a reliable and a precise means in predicting TBH of an individual. Many researchers developed regression formulae to estimate stature from long bones to predict stature. The equations produced for one population do not always give accurate results for another due to differences in race, environment, and lifestyle.[43]

Although foot and forearm lengths are good predictors of TBH, yet, the correlation between the percutaneous foot and forearm lengths with TBH is deficient in literature. The hypothesis that ventral forearm and foot lengths are almost the same together with the lack of anthropometric data concerning the local population in Egyptian locality encouraged us to present this study aiming to find out the correlation between foot length, forearm length and the TBH in an attempt to form regression formulae to estimate the height using these measurements.

## MATERIAL AND METHODS

This study was conducted on 1000 adult Egyptian medical students from Ain-Shams University (500 males and 500 females). The procedure, aims & objectives of the study were informed & explained to the study groups. Selected subjects were apparently healthy and without any apparent skeletal or pathological abnormalities of limb and spine. They were all native Egyptians from different districts of Cairo belonging to different socio-economic status. The age of the subjects ranged from 17-23 years. The study procedure was under permission from the institution as well as from the subjects who were to participate.

All the measurements were taken at a fixed time between 2:00 - 4:00 p.m. to eliminate discrepancies due to diurnal variation. Furthermore, the measurements were recorded by the same person to minimize the errors in methodology. Each measurement was taken thrice, and the mean was considered for further analysis.

The Height of the individual (TBH) was measured in the standing erect anatomical position with bare feet vertically in midline from heel to vertex (the topmost position of the head) using height measure stadimeter (Detecto, WEBB CITY, MO, U.S.A) in centimeters. The subject's head was positioned in the Frankfort horizontal plane[5].

Foot length (Fo. L) was measured as a direct distance from the most prominent point of the back of the heel to the tip of the big toe or to the tip of the second toe if the second toe was longer.[44] Foot length was measured by a spreading caliber in centimeters while the left foot is on the ground.

The forearm length (Fr. L) was defined as the direct distance between the middle of the flexion crease on the elbow to the middle of the distal flexion crease of the wrist. The left forearm was measured in the sitting position with the elbow is semi-flexed using a standard measuring tape.[45] A single person took all the measurements to avoid interpersonal errors.

### *Statistical Analysis*

All the study analyses were done by using Statistical Analysis System Software package (SAS, version 9.0). Descriptive analysis was done to calculate the mean ± SD and the range of studied measurements among all subjects and by their sex. Also, correlation analysis was done to correlate the body height with the studied forearm and foot lengths in the studied subjects and according to their sex. Finally, univariate linear regression analysis was performed to build up the regression formula predicting the body height according to the studied forearm and foot lengths among the studied subjects and by their sex.

The intraclass correlation (ICC) was also used to test the agreement between forearm and foot lengths in all studied subjects according to sex as well as among male and female subjects.

## RESULTS

A cohort of 1000 subjects; 500 males and 500 females were studied to determine the correlation between body height with the forearm and foot lengths among them and to build up a regression formula predicting the association between body height and forearm and foot lengths in the studied subjects and according to their sex.

The mean distribution of the studied measurements of all studied subjects is represented in (Table 1). The mean TBH was 165.8 ± 8.04 with a statistically significant difference between males and females being higher in males. Similarly, the forearm and foot lengths were higher in males than females with as well a statistically significant difference (*P<.001*) (Table 1).

Table (2) presented the correlation between TBH and the foot length (Fo. L) among the studied subjects. There was a significant positive correlation which was marked among female subjects. The correlation coefficient (r) was + 0.69 among all studied subjects, + 0.40 among male subjects and + 0.76 among the studied females (Figs. 1 & 2).

Table (3) represented the correlation between the total body height and the forearm length among the studied subjects and by their sex. There was a significant positive correlation among female subjects. The correlation coefficient (r) was+ 0.66 among all studied subjects, + 0.76 among the studied female subjects while it was + 0.43 among the studied male subjects (Figs. 3 & 4).

Linear regression analysis for the association of body height and the foot length among the studied subjects is represented in (Table 4). There was a significant positive association between the total body height and foot length. Increasing foot length by 1 cm is expected to increase total body height by 3.1 cm among all subjects, 1.6 cm among male and 3.1 cm among female subjects. The foot length was also found to explain 47% of the variation observed in the body height of all studied subjects, 16% in male subjects and 58% in female subjects. According to the obtained regression formula, when the foot length would be 20 cm, the body height is expected to be 160.5 cm among male subjects (body height = 128.5 + 1.6 X 20), and 147.1 cm among female subjects (body height = 85.1 + 3.1 X 20).

### *Regression Formulae:*

Total subjects: body height = 87.6 + 3.1 X foot length.

Male subjects: body height= 128.5 + 1.6 X foot length.

Female subjects= 85.1 + 3.1 X foot length.

Linear regression analysis for the association of the TBH and the Fr. L among the studied subjects is represented in (Table 5). There has been a significant positive association between the total body height and the forearm length where increasing forearm length by 1 cm will lead to an increase in body height by 3.2 cm among all subjects, 1.9 cm among males and 2.6 cm among female subjects. The forearm length also explained 45% of the variation observed in the body height of all studied subjects, 20% in male subjects and 43% in female subjects. According to the obtained regression formula, when the forearm length would be 20 cm, the predicted body height will be 122.2 + 1.9 X 20= 160.2 cm among male subjects, and it will be 97.1 + 2.6 X 20= 149.1 cm among female subjects.

### *Regression Formulae:*

Total subjects: body height = 85.8 + 3.2 X forearm length.

Male subjects: body height = 122.2 + 1.9 X forearm length.

Female subjects: body height = 97.1 + 2.6 X forearm length.

Table (6) showed the agreement between forearm and foot length in the studied subjects. In all subjects, the intraclass correlation (ICC) coefficient denotes a moderate significant agreement between forearm and foot length. This finding was more marked and indicated a good agreement among female subjects with ICC was 0.70 (95% CI = 0.55-0.85), whilst the ICC was 0.32 among male subjects indicating a fair agreement.

**Table 1:** The mean total body height (TBH), foot length (Fo. L) and forearm length (Fr. L) of the studied subjects.

| Measurements in cm | Total subjects (n= 1000) | Male subjects (n= 500) | Female subjects (n= 500) | *P value* |
|---|---|---|---|---|
| TBH Mean ± SD (range) | 165.8 ± 8.04 (146-185.3) | 170.3 ± 6.5 (158-185.3) | 159.6 ± 5.5 (146-168) | *<0.001** |
| Fo. L Mean ± SD (range) | 25.1 ± 1.8 (21-32.2) | 25.9 ± 1.6 (22.7-32.2) | 23.9 ± 1.3 (21-26) | *<0.001** |
| Fr. L Mean ± SD (range) | 24.7 ± 1.7 (21-28) | 25.4 ± 1.5 (22.5-28) | 23.7 ± 1.4 (21-26.5) | *<0.001** |

*Significant

**Table 2:** Correlation coefficient between total body height (TBH) and foot length (Fo. L) among all studied subjects.

| | r coefficient | *P value* |
|---|---|---|
| Total subjects (n= 1000) | + 0.69 | *<0.001* |
| Male subjects (n= 500) | + 0.40 | *0.02* |
| Female subjects (n= 500) | + 0.76 | *<0.001* |

**Table 3:** Correlation coefficient between the total body height (TBH) and forearm length (Fr. L) among all studied subjects

| | r coefficient | *P value* |
|---|---|---|
| Total subjects (n= 1000) | + 0.66 | *<0.001* |
| Male subjects (n= 500) | + 0.43 | *0.01* |
| Female subjects (n= 500) | + 0.74 | *0.001* |

**Table 4:** Linear regression analysis for the association of the total body height (TBH) and foot length (Fo. L) among the studied subjects.

| | β coefficient* | R2 | *P value* |
|---|---|---|---|
| Total subjects (n= 1000) | 3.1 | 0.47 | *<0.001* |
| Male subjects (n= 500) | 1.6 | 0.16 | *0.02* |
| Female subjects (n= 500) | 3.1 | 0.58 | *<0.001* |

**Table 5:** Linear regression analysis for the association of the total body height (TBH) and forearm length (Fr. L) among all studied subjects.

| | β coefficient* | R2 | *P value* |
|---|---|---|---|
| Total subjects (n= 1000) | 3.2 | 0.45 | *<0.001* |
| Male subjects (n= 500) | 1.9 | 0.20 | *0.01* |
| Female subjects (n= 500) | 2.6 | 0.43 | *0.001* |

**Table 6:** The intraclass correlation (ICC) coefficient (agreement between forearm and foot lengths) between forearm length (Fr. L) and foot length (Fo. L) in the studied subjects.

| | ICC Coefficient (95% CI) | *P value* |
|---|---|---|
| Total subjects (n= 100٠) | 0.55 (0.23-0.87) | *<0.001** |
| Male subjects (n= 50٠) | 0.32 (0.15-0.49) | *0.28* |
| Female subjects (n= 50٠) | 0.70 (0.55-0.85) | *0.001** |

*Significant

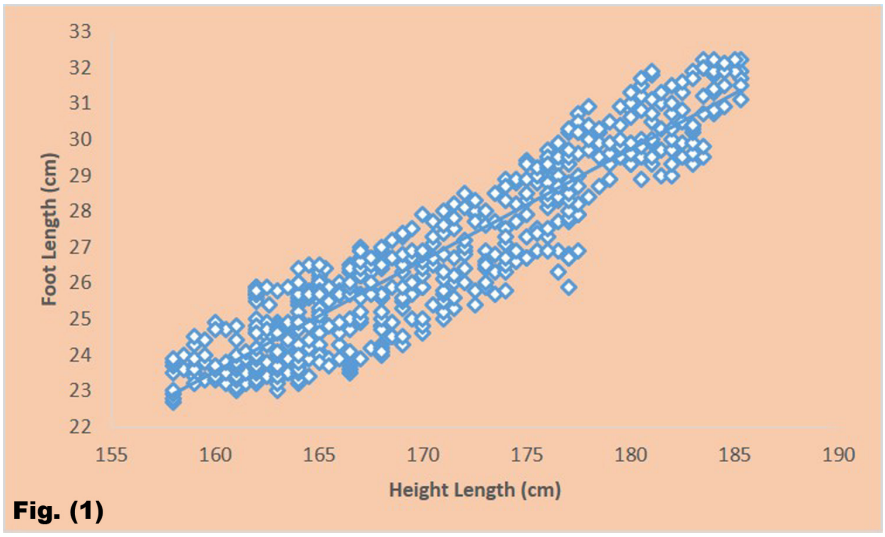


**Fig. 1:** Scatter plot for the correlation between body height and foot length in male subjects (n500 =).

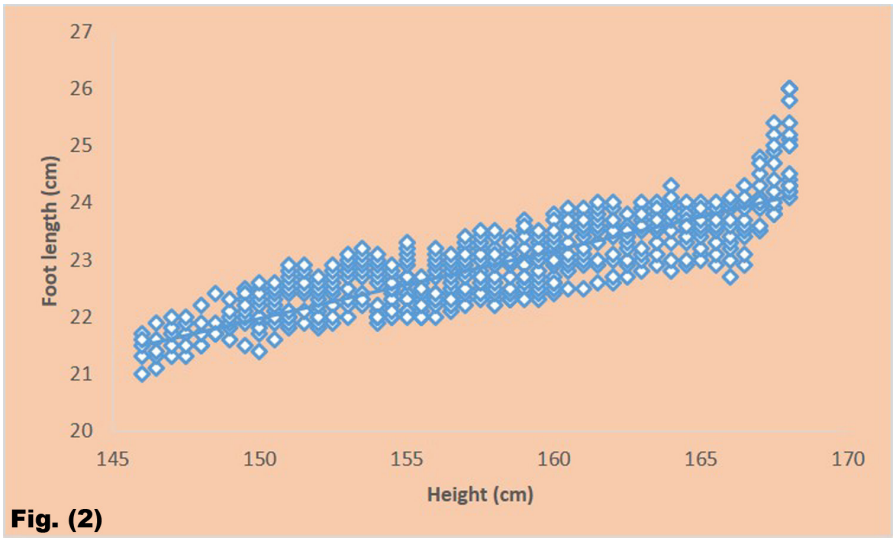


**Fig. 2:** Scatter plot for the correlation between body height and foot length in female subjects (n500 =).

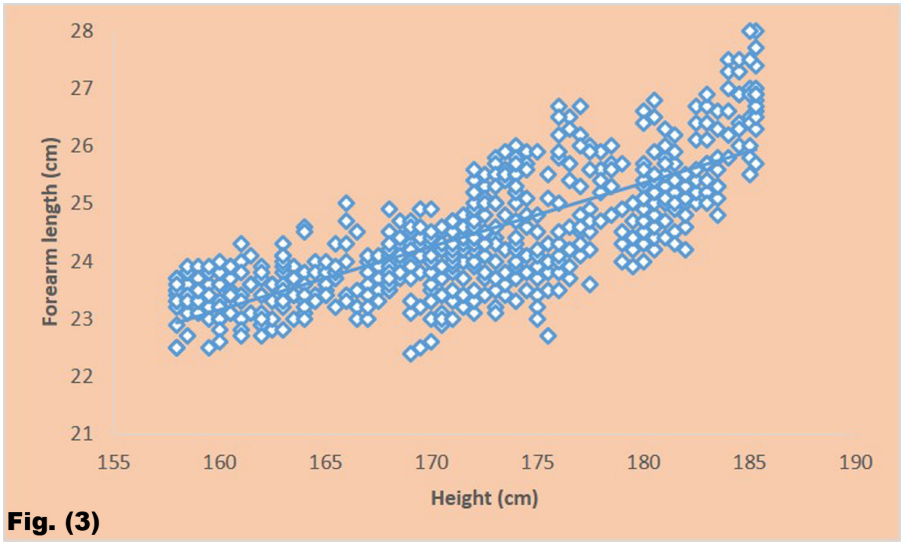


**Fig. 3:** Scatter plot for the correlation between body height and forearm length in male subjects (n500 =).

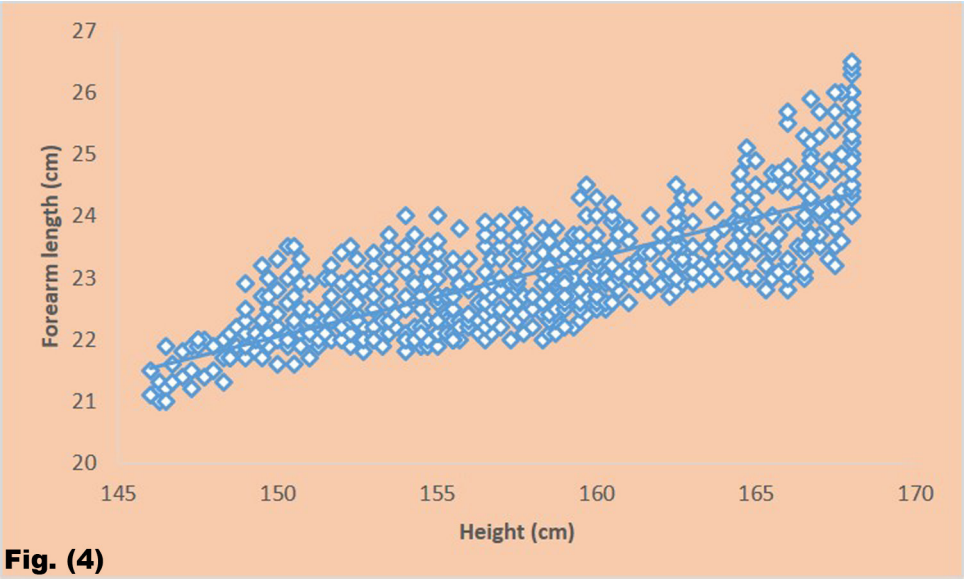


**Fig. 4:** Scatter plot for the correlation between body height and forearm length in female subjects (n500 =).

## DISCUSSION

Prediction of stature from other body parts is of importance in forensic and anthropological studies for the identification of unknown individuals or amputated limbs.[46, 47] Apart from studying bone length, percutaneous body parts lengths in clinical practice are of benefit in cases of patients who cannot stand or suffering from deformities of the vertebral column.[48]

There are a lot of variations in estimating stature from limb measurements among people of different regions & races. Hence a calling demand to conduct more studies among people of different regions & ethnicity so that stature estimation becomes more reliable & identity of an individual is easily established.[43] Even though the foot length and forearm length have been separately studied in relation to the total body height, the correlation between both of them has not been studied. Our study was implicated to a determined age group (17-23 years) to eliminate the differences caused by the age factor.

The present study accomplished a correlation between TBH and the two measurements separately. Totally, our results showed that the correlation is higher as regard foot length (r = +0.69) than forearm length (r = +0.66). In general, males presented a lower correlation coefficient than females (+0.40 and +0.43 in males & +0.76 and +0.74 in females respectively). The advantage of foot length over forearm length prediction of the TBH is explained by the fact that its ossification and maturation occur earlier than other long bones of the body.[49]

Our analysis revealed a pattern of sexual dimorphism in the correlation between TBH and lengths of the forearm and foot with a higher correlation in females than males as males presented a lower correlation coefficient than females. This finding was also proved by Geetha *et al*. (2015)[50].

Linear regression is a reliable method for estimating the relationship between stature and body fragments.[51] Although many studies presented regression formulae to estimate TBH from foot,[11,13] yet the need to establish new ones is still evident due to the local variations in different communities. The differences are off course due to ethnic, gender and age differences.[52]

Foot length gained more attention as most studies proved that it provides the highest reliability and accuracy in estimating stature of an unknown individual.[37] Our study showed that the TBH increases by 3.1 cm for each 1 cm increase in the foot length (1.6 cm in males and 3.1 cm in females). This formula is more or less similar to that of Mansur *et al*., (2012a)[37].

Sexual dimorphism in the formulae was reported similarly by Qamra *et al*., (1980)[53] in North West Indian population and Ashizawa *et al*., (1997)[54] in Javanese, Filipinas and Japanese who attributed this dimorphism to the fact that women have shorter stature and smaller feet.

As regard forearm, again an obvious sexual dimorphism was detected. Our regression formula showed that increasing forearm length by 1 cm increased the body height by 3.2 cm among all subjects (1.9 cm in males and 2.6 cm in females). The main difference between our formula and the other ones is explained by the fact that most studies estimated the length of the forearm from its dorsal aspect mostly from the olecranon process to the styloid process of the ulna[5, 9] or from length of the ulna.[27,38,41,42,55] In our study, we delivered a new measuring method (from elbow crease to wrist crease ventrally). This measurement was considered of value as it showed a considerable degree of agreement between forearm length and that of the foot.

Based on the results, the hypothesis that the percutaneous length of the foot is about equal to the length of the forearm has not been yet proved or neglected. Our study showed that there is a considerable degree of agreement between the percutaneous forearm and foot lengths using the intraclass correlation coefficient. This agreement was more evident in female subjects than males.

## CONCLUSIONS

Total body height was positively correlated with lengths of foot and forearm. The correlation was higher with foot length (r = +0.69) than forearm length (r = +0.66). The correlation was higher in females. Regression formulae could be derived for the association between total body height and foot and forearm lengths in both sexes. Noticeably a significant agreement was marked between the percutaneous foot and forearm lengths with a higher intraclass correlation coefficient (ICC) in females (0.70) than males (0.32).

## CONFLICT OF INTERESTS

There are no conflicts of interest.

## REFERENCES


1. Mohanty SP, Babu SS, Nair NS. The use of arm span as a predictor of height: A study of South Indian women. J Orthop Surg (Hong Kong). 2001; 9(1): 19-23.

2. Kwok T, Lau E, Woo J. The prediction of height by arm-span in older Chinese people. Ann Hum Biol. 2002;29:649-56.

3. Agnihotri AK, Agnihotri S, Jeebun N, Googoolye K. Prediction of stature using hand dimensions. J Forensic Leg Med. 2008; 15: 479-82.

4. Fatmah. Predictive equations for estimation of stature from knee height, arm span and sitting height in Indonesian Javanese elderly people. Int J Med and Med Sci. 2009; 1:456-

5. Madden AM, Tsikoura T, Stott DJ. The estimation of body height from ulna length in healthy adults from different ethnic groups. J Hum Nutr Diet. 2012a; 25(2): 121-128.

6. Felici A, Verweij J, Sparreboom A. Dosing strategies for anticancer drugs: the good, the bad and body-surface area. Eur J Cancer. 2002; 38(13): 1677-1684.

7. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. Nutr Res Rev. 2010; 23(2): 247-269.

8. Coe TR, Halkes M, Houghton K, Jefferson D. The accuracy of visual estimation of weight and height in pre-operative supine patients. Anaesthesia. 1999; 54(6): 582-586.

9. Agnihotri AK, Kachhwaha S, Jowaheer V, Singh AP. Estimating stature from percutaneous length of tibia and ulna in Indo-Mauritian population. Forensic Sci Int. 2009a; 187(1-3): 109-3.

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

11. Sanli SG, Kizilkanat ED, Boyan N, Ozsahin ET, Bozkir MG, Soames R, Erol H, Oguz O. Stature estimation based on hand length and foot length. Clin Anat 2005a; 18(8): 589-596.

12. Uhrova P, Benus R, Masnicova S. Stature estimation from various foot dimensions among Slovak population. J Forensic Sci. 2013; 58(2): 448-451.

13. Uhrova P, Benus R, Masnicova S, Obertova Z, Kramarova D, Kyselicova K, Dornhoferova M, Bodorikova S, Nescakova E. Estimation of stature using hand and foot dimensions in Slovak adults. Leg Med (Tokyo). 2014.

14. Trotter M, Gleser GC. Estimation of stature from long bones of American Whites and Negroes. Am J Phys Anthropol. 1952; 10(4): 463-514.

15. Trotter M, Gleser G C. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. Am J Phys Anthropol. 1958; 16(1): 79-123.

16. Chumlea WC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. J Am Geriatr Soc. 1985; 33(2): 116-120.

17. Cockram DB, Baumgartner RN. Evaluation of accuracy and reliability of calipers for measuring recumbent knee height in elderly people. Am J Clin Nutr. 1990; 52(2): 397-400.

18. Cereda E, Bertoli S, Vanotti A, Battezzati A. Estimated height from knee-height in Caucasian elderly: implications on nutritional status by mini nutritional assessment. J Nutr Health Aging. 2010; 14(1): 16-22.

19. Saxena SK. A study of correlations and estimation of stature from hand length, hand breadth and sole length. Anthropol Anz. 1984; 42(4): 271-276.

20. Musgrave JH, Harneja NK. The estimation of adult stature from metacarpal bone length. Am J Phys Anthropol. 1978; 48(1): 113-119.

21. Steele MF, Mattox JW. Correlation of arm-span and height in young women of two races. Ann Hum Biol. 1987; 14(5): 445-447.

22. Steele MF, Chenier TC. Arm-span, height, and age in black and white women. Ann Hum Biol. 1990; 17(6): 533-541.

23. Kwok T, Whitelaw MN. The use of arm-span in nutritional assessment of the elderly. J Am Geriatr Soc. 1991; 39(5): 492-496.

24. De LE, Lemma F, Tesfaye F, Demisse T, Ismail S. The use of armspan measurement to assess the nutritional status of adults in four Ethiopian ethnic groups. Eur J Clin Nutr. 2002; 56(2): 91-95.

25. Popovic, S.; Bjelica, D.; Molnar, S.; Jaksic, D. & Akpinar, S. Body height and its estimation utilizing arm span measurements in Serbian adults. Int. J. Morphol.,31(1):271-9, 2013

26. Perissinotto E, Pisent C, Sergi G, Grigoletto F. Anthropometric measurements in the elderly: age and gender differences. Br J Nutr. 2002; 87(2): 177-186.

27. Forman MR, Zhu Y, Hernandez LM, Himes JH, Dong Y, Danish RK *et al*., Arm span and ulnar length are reliable and accurate estimates of recumbent length and height in a multiethnic population of infants and children under 6 years of age. J Nutr. 2014; 144(9): 1480-1487.

28. Keane DF, Lindley E. Use of hand-to-hand measurements for body composition monitoring in patients with inaccessible or amputated feet. J Ren Care. 2014.

29. Rodriguez S, Rodriguez-Calvo MS, Gonzalez A, Febrero-Bande M, Munoz-Barus JI. Estimating height from the first and second cervical vertebrae in a Spanish population. Leg Med (Tokyo) 2016; 19: 88-92.

30. Saraf A, Kanchan T, Krishan K, Ateriya N, Setia P. Estimation of stature from sternum - Exploring the quadratic models. J Forensic Leg Med. 2018; 58: 9-13.

31. Kim W, Kim YM, Yun MH. Estimation of stature from hand and foot dimensions in a Korean population. J Forensic Leg Med. 2018; 55: 87-92.

32. Taura MG, Adamu LH, Gudaji A. Variation of facial features among three African populations: Body height match analyses. Homo. 2017; 68(1): 69-79.

33. Chittawatanarat K, Pruenglampoo S, Trakulhoon V, Ungpinitpong W, Patumanond J. Height prediction from anthropometric length parameters in Thai people. Asia Pac J Clin Nutr. 2012; 21(3): 347-354.

34. Hemy N, Flavel A, Ishak NI, Franklin D. Estimation of stature using anthropometry of feet and footprints in a Western Australian population. J Forensic Leg Med. 2013; 20(5): 435-441.

35. Kanchan T, Krishan K, Geriani D, Khan IS. Estimation of stature from the width of static footprints-insight into an Indian model. Foot (Edinb ). 2013; 23(4): 136-139.

36. Pablos A, Gomez-Olivencia A, Garcia-Perez A, Martinez I, Lorenzo C, Arsuaga JL. From toe to head: use of robust regression methods in stature estimation based on foot remains. Forensic Sci Int. 2013; 226(1-3): 299-7.

37. Mansur DI, Haque MK, Karki RK, Khanal K, Karna R. Estimation of stature from foot length in adult Nepalese population and its clinical relevance. Kathmandu Univ Med J (KUMJ). 2012a; 10(37): 16-19.

38. Athawale MC. Estimation of height from lengths of forearm bones. A study of one hundred maharashtrian male adults of ages between twenty-five and thirty years. Am j phys anthropol. 1963a; 21: 105-112.

39. Dennis DM, Hunt EE, Budgeon CA. Measuring height in recumbent critical care patients. Am J Crit Care. 2015; 24(1): 41-47.

40. Lal CS, Lala JK. Estimation of height from tibial and ulnar lengths in North Bihar. J Indian Med Assoc. 1972; 58(4): 120-121.

41. Gauld LM, Kappers J, Carlin JB, Robertson CF. Height prediction from ulna length. Dev Med Child Neurol. 2004; 46(7): 475-480.

42. Weidauer L, Wey H, Slater H, Moyer-Mileur L, Specker B. Estimation of length or height in infants and young children using ulnar and lower leg length with dual-energy X-ray absorptiometry validation. Dev Med Child Neurol. 2014; 56(10): 995-1000.

43. Brits DM, Bidmos MA, Manger PR. Stature estimation from the femur and tibia in Black South African sub-adults. Forensic Sci Int. 2017; 270: 277.

44. Rutishauser IH. Prediction of height from foot length: Use of measurement in field surveys. Arch Dis Child. 1968; 43(229): 310-312.

45. Naik MA, Sujir P, Tripathy SK, Goyal T, Rao SK. Correlation between the forearm plus little finger length and the femoral length. J Orthop Surg (Hong Kong ). 2013; 21(2): 163-166.

46. Cordeiro C, Munoz-Barus JI, Wasterlain S, Cunha E, Vieira DN. Predicting adult stature from metatarsal length in a Portuguese population. Forensic Sci Int. 2009; 193(1-3): 131-134.

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

48. Auyeung TW, Lee JS, Kwok T, Leung J, Leung PC, Woo J. Estimation of stature by measuring fibula and ulna bone length in 2443 older adults. J Nutr Health Aging. 2009; 13(10): 931-936.

49. Dharap AS, Al-Hashimi H, Kassab S, Abu-Hijleh MF. Incidence and ossification of sesamoid bones in the hands and feet: a radiographic study in an Arab population. Clin Anat. 2007; 20(4): 416-423.

50. Geetha GN, Swathi, Athavale SA. Estimation of Stature From Hand and Foot Measurements in a Rare Tribe of Kerala State in India. J Clin Diagn Res. 2015; 9:1-4.

51. Ilayperuma I, Nanayakkara BG, Hasan R, Uluwitiya SM, Palahepitiya KN. Coracobrachialis muscle: morphology, morphometry and gender differences. Surg Radiol Anat. 2016; 38(3): 335-340.

52. Pawar RM, Pawar MN. "Foot length--A functional parameter for assessment of height". Foot (Edinb ). 2012; 22(1): 31-34.

53. Qamra SR, Indar Jit and Deodhar SD. A model for reconstruction of height from foot measurements in an adult population of Northwest India. Indian J Med Res Jan 1980;71:77-83.

54. Ashizawa K, Kumakura C, Kusumoto A, Narasaki S. Relative foot size and shape to general body size in Javanese, Filipinas and Japanese with special reference to habitual footwear types. Ann Hum Biol. 1997; 24(2): 117-129.

55. Gauld LM, Kappers J, Carlin JB, Robertson CF. Prediction of childhood pulmonary function using ulna length. Am J Respir Crit Care Med. 2003; 168(7): 804-809.

# العلاقة المترابطة بين طول الجسم وأطوال القدمين والساعدين عن طريق الجلد لدى المصريين البالغين

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## ملخص البحث

**المقدمة:** قامت دراسات عديدة بالربط بين إجمالي ارتفاع الجسم وأطوال مختلف أجزاء الجسم، لا يوجد دراسات للارتباط بين أطوال القدم والساعد وإجمالي ارتفاع الجسم.

**الهدف من البحث:** هو ربط هذه القياسات الثلاث واستخراج معادلات الانحسار لتقدير الارتفاع الكلي للجسم الحي من أطوال القدم والساعد عبر الجلد.

**المادة وطرق البحث:** شارك في الدراسة ١٠٠٠ طالب وطالبة مصريين (٥٠٠ من الذكور و٥٠٠ من الإناث) من الفئة العمرية (٢٠-٢٣ سنة)، تم قياس الطول الكلي للجسم في وضع الوقوف وطول القدم وطول الساعد، تم تحليل جميع القياسات إحصائيًا، وتم إنشاء معادلة انحسار لحساب إجمالي ارتفاع الجسم باستخدام أطوال القدم والساعد من خلال الحالات المدروسة مع اعتبار الجنس، كذلك تم عمل معامل الارتباط للربط بين أطوال القدم والساعد في المجموعات المختبرة مع اعتبار الجنس.

**النتائج:** وجد أن هناك علاقة إيجابية بين إجمالي ارتفاع الجسم وأطوال القدم والساعد، كان الارتباط أعلى مع طول القدم ($r = +0.69$) من طول الساعد ($r = +0.67$) وكان الارتباط أعلى في الإناث، تم إنشاء تحليل الانحسار الخطي ومعادلات الانحسار للربط بين إجمالي ارتفاع الجسم وأطوال القدم والساعد في كلا الجنسين، كان هناك توافق هام بين أطوال القدم والساعد مع وجود معامل ارتباط أعلى في الإناث (٠,٧٠) من الذكور (٠,٣٢).

**الخلاصة:** ارتبط إجمالي ارتفاع الجسم بشكل إيجابي بأطوال القدم والساعد وكان الارتباط أعلى مع طول القدم من طول الساعد كما كان الارتباط أعلى في الإناث وأمكن اشتقاق معادلات الانحسار للربط بين إجمالي ارتفاع الجسم وأطوال القدم والساعد في كلا الجنسين، وبشكل ملحوظ كان هناك توافق هام بين أطوال القدم والساعد مع وجود معامل ارتباط أعلى في الإناث عن الذكور.