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Does Upper Arm Length, Arm Span, and Foot Length Serve as Good Predictors for Stature? A Cross-Sectional Study among Northern Nigerians

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Stature estimation is an important identification process in the field of physical and forensic anthropology and for industrial design. The study aims to determine if upper arm length, foot length, and arm span could be good predictors for stature among northern Nigerians.
Methods: The study adopted a descriptive cross-sectional design using a multi-stage random sampling technique. 400 northern Nigerians (200 males and 200 females) were involved in the research and data were collected via direct anthropometric method using a stadiometer, and meter rule. The data obtained were analyzed using the IBM SPSS and probability was stated ($p<0.05$).
Results: The findings of the study show that males have a mean value for the standing height, upper arm length, foot length, and arm span as 171.97±6.68 cm, 32.62±2.55 cm, 25.76±1.17 cm, 181.72±7.83 cm respectively, and females were 163.33±5.96 cm, 35.23±2.19 cm, 23.04±1.51 cm, and 168.67±6.68 cm for standing height, upper arm length, foot length, and arm span which has shown sexual differences and age-related differences ($p<0.05$). The upper arm was found to be a weak predictor for stature (R=0.045, SEE=7.66), foot length and arm span were good predictors of stature (R=0.73, SEE=5.24 and R=0.83, SEE=4.25) univariately. Multivariate analysis of the upper arm length, foot length, and arm span were better predictors for stature (R=0.85, SEE=4.07).
Conclusion: The foot length and arm span are good predictors of stature and the findings will be useful to forensic anthropologists

Keywords: Forensic anthropology; upper arm length; stature estimation; Northern Nigerians; foot length and arm span.

1. INTRODUCTION

Anthropometric measures have advanced in building biological profiles such as stature, sex, and ancestry for identification and classification purposes [1]. Building a biological profile has been validated in various places on different races due to well-defined measurements of the population that have been established. However, there is a concern that some ethnic, races, and countries have a dearth in the literature relating to the metric dimensions of the body. This has resulted in numerous challenges where implantation rarely becomes impossible because no established dimensions exist. Environmental, genetic, cultural, diet, and hormonal factors could influence an anthropometric dimension of a specific population rendering it inaccurate to use obtainable data in another population [2-4]. This study aims to generate anthropometric dimensions and evaluate how well are they in the prediction of stature among the northern Nigerians.

The upper arm length, foot length, and arm span are parameters of interest in this study, the upper arm length is a vertical measurement that runs from the lateral tip acromion down to the distal part of the arm (lateral and medial epicondyle) and has been used for some medical application such as nutritional assessment, body proportions, prosthetic fittings, muscle wasting and so on. Several authors have conducted anthropometric studies and have reported inconsistent values across different populations [5-10].

The foot length has been explored widely for various reasons; mostly for shoe design and forensic approaches. It also has some medical applications in pediatric growth assessment and prosthetic designs. Among different populations, the findings are inconsistent [11-14]. The arm span is not excluded, findings also have variation in different populations and time [15-17].

However, the variation observed further suggests that even in a particular population, diet, and lifestyle could also be attributed to the variations observed. Though, considering the numerous works that abound in different populations and the dearth of literature on northern Nigeria there is a need for continuous re-evaluation of the anthropometric dimension of a population to remain current and relevant. This has motivated the interest of this study to generate anthropometric dimensions and predict stature using the parameter for forensic and industrial applications.

2. MATERIALS AND METHODS

2.1 Study Design

This study employed a cross-sectional descriptive approach to collect data on standing height, upper arm length, foot length, arm span, and age in northern Nigeria. The study included

four hundred Nigerian northerners currently residing in Kano State, Nigeria, including two hundred males and two hundred females. The study's participants range in age from 17 to 40 years. The study lasted six months (January 2024-June 2024), with the first three months spent collecting data and the second three months managing and designing the study's article. Kano City in Kano State, Nigeria was used as a sample frame to draw subjects from different northern states of Nigeria.

2.2 Sampling Size and Techniques

Four hundred Nigerian northerners were recruited via multi-stage random sampling techniques to ensure all subjects had an equal chance of being selected and the minimum sampling size was determined using the Taro Yamane formula for quantitative research.

2.3 Selection Criteria

In the course of the study, the researcher only recruited subjects whose grandparents and parents were of Nigeria's northern origin, between the age interval of 17 years to 40 years, and had no morphological defect that could alter the stature or the areas of measurements. Lastly, only subjects who consented to participate by filling out the consent form were allowed. The study further excluded subjects whose origin is from northern Nigeria and had some morphological defect that could alter stature and the measured part of interest. The subjects who failed to consent were also excluded from the study.

2.4 Method of Data Collection

Data were collected via a semi-structured descriptive questionnaire following a personal interview and direct measurements of the body dimensions. The questionnaire was designed in two sections; A containing the bio data of the subjects, and Section B, the under-listed parameters of interest and the scoring system. The personal interview was adopted to ensure the subjects met the inclusion criteria and also to validate that the information given was correct.

Fig. 1. Measurement of the foot length (*source: field works*)

Fig. 2. Measurement of standing height (*source: fieldwork*)

Using a ZT-160 stadiometer the height of the subjects was measured, and a non-stretchable and a mega-size caliper were used to measure the upper arm length and foot length. A meter rule was also used to measure the arm span. All measurement follows the international standard of anthropometric measurements.

2.5 Anthropological Landmarks

- **Standing height:** it is a vertical measurement of the human body that runs from the vertex of the head to the sole when the subject is standing upright in an anatomical position.
- **Upper arm length:** this measurement runs from the lateral tip acromion down to the distal part of the arm (lateral and medial epicondyle)
- **Foot length**. This is the measurement of the foot from the big toe to the distal talus of the leg
- **Arm span;** this is a horizontal measurement of the human body from the tip of the third finger/digit to the opposite tip of the third finger/digit

2.6 Method of Data Analysis

Data from the study were analyzed using IBM SPSS version 25 and presented as mean±standard deviation. The T-test and ANOVA were employed as inferential statistics to assess sexual and age-related differences and univariate and multivariate analyses were performed to estimate stature using individual and combination factors. Statistical significance was defined as $p < 0.05$, with 95% confidence range.

3. RESULTS

The study comprised four hundred northern subjects between the ages 17- 40 years and Table 1, shows the descriptive statistics of the parameters for Northern Nigeria. The results present that the minimum and maximum standing heights were 148 cm and 191.2cm respectively with a mean value of 167.65cm, the upper arm length has a mean value of 33.93cm whereas the minimum and maximum values are 23cm and 45.3cm. The foot length was measured and our result presented that the minimum, maximum, and mean values were 18.6 cm, 34.1cm, and 24.40cm respectively. The arm span had a mean value of 175.19 cm with minimum and maximum values of 150cm and 201 cm respectively.

Table 2 explores the sexual differences observed in the studied parameters among Northern Nigeria and the results present that male has a mean value for standing height, upper arm length, foot length, and arm span as 171.97±6.68 cm, 32.62±2.55 cm, 25.76±1.17 cm, 181.72±7.83 cm respectively. While the females show

163.33±5.96 cm, 35.23±2.19 cm, 23.04±1.51 cm, and 168.67±6.68 cm for standing height, upper arm length, foot length, and arm span. The comparison between the males and the females further shows that there are statistical differences observed in standing height, upper arm length, foot length, and arm span ($p<0.05$).

Table 3, explores the age-related differences in standing height, upper arm length, foot length, and arm span and our findings show that the mean value increases with the increase in age. However, the findings have displayed statistical age-related differences in Standing height, upper arm length, foot length, and arm span ($p<0.05$).

Table 4 present the univariate regression for stature estimation (S) among northern Nigeria and our findings explore that upper arm length is a weak predictor for stature (R=0.045, SEE=7.66), the foot length showed a strong predictor for stature where the R was observed as 0.73 and SEE was 5.24. and the arm span also shows a strong correlation and a good predictor for stature (R=0.83, SEE=4.25). The collinearity has shown that upper arm length, foot length, and arm span are not closely related to stature and could be used as a predictive value (VIF<2.5). From the univariate regression, our study generated models for stature estimation using the upper arm length, stature could be predicted as S=(163.34) +Al(0.13), using foot length, S=(96.49)+FL(2.92) and using Arm span= (53.40)+AS(0.65).

Table 5 showed the multivariate linear regression for stature estimation (S) among northern Nigeria across the sexes and the finding from our study shows that upper arm length, foot length, and arm span are good predictors of stature (R=0.85, VIF<2.5 and SEE<1). For the female population, the result showed that upper arm length, foot length, and arm span were good predictors for stature (R=0.77) with SEE of the studied parameters observed (SEE<1) which further indicates the accuracy of the prediction and the VIF of the upper arm length and foot length was VIF<2 indicating that the parameter is not closely related to the stature and could serve as a good predictors for stature. Among the male population, the upper arm length, foot length, and arm span display a good predictor for stature estimation (R=0.78) with each parameter having SEE less than 1. The collinearity has also shown that upper arm length, foot length, and arm span are accurate and better predictors for stature (VIF<2).

Table 1. Descriptive Statistics of the Parameters for Northern Nigeria

	min	max	Mean	SEM	SD
Age(year)	17	40	22.458	0.2002	4.0042
S (cm)	148	191.2	167.657	0.3832	7.664
AL (cm)	23	45.3	33.928	0.1358	2.7169
Fl (cm)	18.6	34.1	24.402	0.0959	1.9175
AS (cm)	150	201	175.198	0.4888	9.776

: Min= minimum, max=maximum, S=standing height, AL=upper Arm Length, FL=foot length, AS=Arm span, SEM=Standard Error Mean, SD=standard deviation.

Table 2. Sexual differences in the parameters among Northern Nigeria

SEX	Male	Female	T score	p-value	Inference
S	171.97±6.68	163.33±5.96	13.65	0.0001	Sig
AL	32.62±2.55	35.23±2.19	-11.01	0.001	Sig
FL	25.76±1.17	23.04±1.51	20.19	0.001	Sig
AS	181.72±7.83	168.67±6.68	17.92	0.0001	Sig

S=standing height, AL=upper Arm Length, FL=foot length, AS=Arm span, Sig= significant (p<0.05)

Table 3. Age-related differences in the parameters among Northern Nigeria

	<= 17.0	18.0 - 24.7	24.8 - 32.3	32.4+	F	p-value	Inference
S	160.75±5.30	166.95±7.69	170.06±7.06	170.96±6.98	4.88	0.002	Sig
AL	33.00±1.41	34.26±2.73	32.80±2.53	32.92±1.31	7.04	0.0001	Sig
FL	22.80±1.69	24.15±1.92	25.20±1.63	25.89±1.67	9.90	0.0001	Sig
AS	166.70±6.08	173.93±9.47	179.55±9.62	180.33±9.22	9.07	0.001	Sig

S=standing height, AL=upper Arm Length, FL=foot length, AS=Arm span, Sig= significant (p<0.05)

Table 4. Univariate linear regression for Stature estimation (S) among Northern Nigeria

Parameters	B	R	R^2	SEE	Sig. F Change	Collinearity	
						Tolerance	VIF
(constant)	163.34						
AL	0.13	0.045	0.002	7.6658	0.368	0.92	1.08
(constant)	96.49						
FL	2.92	0.73	0.53	5.24	0.0001	0.34	2.50
(constant)	53.40						
AS	0.65	0.83	0.69	4.25	0.0001	0.41	2.46

S=standing height, AL=upper Arm Length, FL=foot length, AS=Arm span

Table 5. Multivariate linear regression for stature estimation (S) among Northern Nigeria

Model	Parameters	B	SEE	R	R^2	Sig	Tolerance	VIF
All	(Constant)	49.595	4.402			.000		
sexes	AL	.169	.078	0.85	0.72	.032	.922	1.085
	FL	1.048	.169			.000	.398	2.514
	AS	.495	.033			.000	.407	2.460
Female	(Constant)	53.651	6.972			.000		
	AL	.318	.173	0.77	0.59	.068	.518	1.929
	FL	1.249	.213			.000	.724	1.381
	AS	.413	.062			.000	.430	2.325
Males	(Constant)	43.721	7.771			.000		
	AL	.012	.133	0.78	0.60	.928	.792	1.263
	FL	.945	.314			.003	.678	1.475
	AS	.570	.051			.000	.581	1.720

a. Dependent Variable: STANDING HEIGHT

S=standing height, AL=upper Arm Length, FL=foot length, AS=Arm span

4. DISCUSSION

The present study has evaluated the estimation of stature from some anthropometric variables of Northern Nigerian samples residing in Kano city. Our findings showed in males the mean values for standing height, upper arm length, foot length, and arm span were 171.97±6.68 cm, 32.62±2.55 cm, 25.76±1.17 cm, and 181.72±7.83 cm respectively, while the standing height, upper arm length, foot length, and arm span were 163.33±5.96 cm, 35.23±2.19 cm, 23.04±1.51 cm, and 168.67±6.68 cm for female subjects. Our findings show that males have higher mean values for standing height, upper arm length, foot length, and arm span compared to females. The statistical differences were significant ($p<0.05$) based on sex for standing height, upper arm length, foot length, and arm span.

The reasons for the observed variation could be attributed to genetic or hormonal factors. Physiologically it is known that males and females have distinct makeup that guides the growth patterns and could lead to noticeable physical variations. The surging increase of testosterone hormone influences growth in males at puberty resulting in the tremendous growth of bones and muscles when compared to females. The differential growth is what leads to variations in physical dimensions among sexes [4,5]. From an evolutionary standpoint, the forces of natural and sexual selection could have also influenced these morphological distinctions. Several evolutionary postulations have been developed to support diverse functions and sexual dimorphism, or the intrinsic disparities in size and appearance between males and females. [5]. The findings of this study agree with the study of Asiwe et al., [5] that upper arm length is significantly different in sexes among the Mgbidi population of Imo State, Nigeria. Among northern Indians, Singh et al., [18] also reported that stature was statistically significant for sex. The same observation was made by Gh et al., [19] in the study of upper limb extremity anthropometry of Iran and Pakistan populations. Krauss et al., [20] on the anthropometry of the foot reported that sexual differences exist in foot measurements; and among the Ikwerre and Okrika ethnic groups of Rivers State, Asiwe et al., [3] have reported that standing height has a significant difference between males and females.

Age-related differences in standing height, upper arm length, foot length, and arm span are presented in Table 3. Our findings revealed statistical age-related differences in all measured parameters ($p<0.05$). Physiologically, it known that the growth of bones ceases after fusion, which occurs between 18 and 27 years. Thus, it is expected that changes in standing height, upper arm length, foot length, and arm span in the age group studied would be minimal compared to the more dramatic growth seen in children and early adolescence. Between 18-22 most bones have ossified.

Furthermore, stature can alter in subtle ways throughout life. Age, posture, spinal compression, and muscular mass are all potential contributing factors. Poor posture, muscular imbalances, and the effects of gravity can all contribute to small height loss over time, especially as we approach our late 30s and early 40s. Our muscle mass normally peaks in our late teens and early twenties, but it might progressively drop if we don't exercise regularly. This drop can have an impact on dimensions including upper arm length, foot length, and arm span.

Age-related differences observed in the study agree with the report by Li et al., [21], Tomassoni et al., [22], and Echeita et al., [23]. Rezende et al., [24], Perissinotto et al., [25] and López-Ortega and Arroyo, [26]. Li et al., [21] reported that foot dimensions increase with age in their sample population.

One of the objectives of this study was to determine if stature could be estimated from upper arm length, foot length, and arm span and results are shown in Table 4. The upper arm length was observed as a weak predictor for stature ($R=0.045$, $SEE=7.66$), the foot length and arm span were strong predictors ($R=0.73$, $SEE=5.24$, $R=0.83$, $SEE= 4.25$ respectively) The collinearity has shown that upper arm length, foot length, and arm span are not closely related to stature and could be used as a predictive value ($VIF<2.5$). Our findings are consistent with [13, 27-35]. On the contrary, the findings from our study disagree with the study among the Mgbidi population of Imo State, Nigeria [5], where Asiwe et al., [5], emphasized that muscle mass and body composition could affect and influence the estimation of stature.

The result of multivariate regression for stature estimation is presented in Table 5. The upper arm length, foot length, and arm span are good predictors of stature ($R=0.85$, $VIF<2.5$, and $SEE<1$) when combined irrespective of sex. Upper arm length, foot length, and arm span were good predictors of stature ($R=0.77$) for the female population. The SEE of the studied parameters was observed to be less than 1, indicating prediction accuracy. The VIF of the upper arm length and foot length was <2, suggesting that the parameters are not closely related to stature and could be useful predictors of stature. With each measure having a SEE smaller than 1, the male population's upper arm length, foot length, and arm span showed good predictors for stature estimate ($R=0.78$). The findings further suggest that for both males and females, the upper arm length, foot length, and arm span are good predictors for stature and this agrees with [5, 27-35] that the studied parameter are good predictors for stature estimation in various populations.

5. CONCLUSION

The univariate regression revealed that foot length and arm span are better predictors of stature. The multivariate regression revealed that in both males and females, the upper arm length, foot length, and arm span could serve as better predictors for stature estimation. These findings are useful to physical and forensic anthropologists.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of manuscripts.

CONSENT

A written consent was distributed to all the subjects explaining the nature of the research and only those who consented were allowed to participate in the study. The consents were retrieved and preserved by the authors.

ETHICAL CONSIDERATION

The study was approved by the research and ethics committee of the University of Port Harcourt, Port Harcourt Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anjani RC, Artaria MD, Singsuwan P, Arunorat J, Mahakkanukrauh P. Biological Identification of Skulls in Indonesian and Thai Populations: Ancestry Estimation, Sex Determination, Stature Estimation, and Age Estimation. International Journal of Morphology. 2024;42(1).
2. Di Fusco SA, Mocini E, Gulizia MM, Gabrielli D, Grimaldi M, Oliva F, Colivicchi F. ANMCO (Italian Association of Hospital Cardiologists) scientific statement: obesity in adults—an approach for cardiologists. Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity. 2024;29(1):1.
3. Asiwe N, Irozulike FC, Wariboko LI, Adheke OM. Health Assessment of the Ikwerres and Okrikas Ethnic Group of Rivers State, Nigeria: Using Body Mass Index and Waist-to-Hip Ratio. Journal of Complementary and Alternative Medical Research. 2023;23(2):27-35.
4. Fewehinmi HB, Okoh PD, Oghenemavwe LE, Amadi MA, Ebieto CE, Bobbo KA, Asiwe N. Facial Analysis of the Igbo Ethnic Group of Nigeria for the Evaluation of Sexual Dimorphism. Asian Journal of Medicine and Health. 2023;21(12):67-75.
5. Asiwe N, Adheke OM, Ezeah I, Okon M, Filima PL, Buseni OV. Discriminant and Multiple Linear Regression Analysis for Sex and Stature Estimation Using Upper Arm and Forearm-Hand Length: A Study among Mgbidi Population of Imo State Nigeria. Asian Journal of Medical Principles and Clinical Practice. 2024;7(1): 295-305.
6. Navid S, Mokhtari T, Alizamir T, Arabkheradmand A, Hassanzadeh G. Determination of stature from upper arm length in medical students. Anatomical Sciences Journal. 2014;11(3):135-40.
7. Hennessey WJ, Falco FJ, Goldberg G, Braddom RL. Gender and arm length: influence on nerve conduction parameters in the upper limb. American Journal of Physical Medicine & Rehabilitation. 1993; 72(4):235.
8. Belt-Niedbala BJ, Ekvall S, Cook CM, Oppenheimer S, Wessel J. Linear growth measurement: A comparison of single arm-lengths and arm-span. Developmental Medicine & Child Neurology. 1986;28 (3):319-24.
9. Datta Banik S, Azcorra H, Valentín G, Bogin B, Dickinson F. Estimation of stature from upper arm length in children aged 4.0 to 6.92 y in Merida, Yucatan. The Indian Journal of Pediatrics. 2012;79:640-6.
10. Marshall WA, Ahmed L. Variation in upper arm length and forearm length in normal British girls: photogrammetric standards. Annals of Human Biology. 1976 Jan 1;3(1):61-70.
11. Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N. Estimation of stature by foot length. Journal of forensic and legal medicine. 2007;14(5):279-83.
12. Masanovic B, Gardasevic J, Arifi F. Relationship between foot length measurements and body height. Anthropologie (1962-). 2019;57(2):227-34.
13. 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. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists. 2005;18(8):589-96.
14. Hill M, Naemi R, Branthwaite H, Chockalingam N. The relationship between arch height and foot length: Implications for size grading. Applied ergonomics. 2017;59:243-50.
15. Quanjer PH, Capderou A, Mazicioglu MM, Aggarwal AN, Banik SD, Popovic S, Tayie FA, Golshan M, Ip MS, Zelter M. All-age relationship between arm span and height in different ethnic groups. European Respiratory Journal. 2014;44(4):905-12.
16. Reeves SL, Varakamin C, Henry CJ. The relationship between arm-span measurement and height with special reference to gender and ethnicity. European journal of clinical nutrition. 1996;50(6):398-400.
17. Mohanty SP, Babu SS, Nair NS. The use of arm span as a predictor of height: A study of South Indian women. Journal of Orthopaedic Surgery. 2001;9(1):19-23.
18. Singh B, Kaur M, Kaur J, Singh M, Batra A. Estimation of stature from forearm length in north Indians–an anthropometric study. International Journal of Basic and Applied Medical Sciences. 2013;3(1):201-4.
19. Gh M, Shiasi M, Hassanzadeh G, Alaghebandha N, Dehbashipour A, Zeidi H, Barbarestani M. Anthropometric characteristics of upper limb in Iranian and Pakistani subjects. Journal of Gorgan

University of Medical Sciences. 2014; 16(3):80-5.
20. Krauss I, Grau S, Mauch M, Maiwald C, Horstmann T. Sex-related differences in foot shape. Ergonomics. 2008;51(11): 1693-709.
21. Li PL, Yick KL, Zhang LY, Keung YC. Evaluation of Age-related Differences in Foot Anthropometry among Women. AATCC Journal of Research. 2023;26: 24723444221147977.
22. Tomassoni D, Traini E, Amenta F. Gender and age-related differences in foot morphology. Maturitas. 2014;79(4):421-7.
23. Echeita JA, Hijmans JM, Smits S, Van der Woude LH, Postema K. Age-related differences in women's foot shape. Maturitas. 2016;94:64-9.
24. Rezende FA, Ribeiro AQ, Priore SE, Franceschinni SD. Anthropometric differences related to genders and age in the elderly. Nutrición Hospitalaria. 2015;32 (2):757-64.
25. Perissinotto E, Pisent C, Sergi G, Grigoletto F, Enzi G, ILSA Working Group. Anthropometric measurements in the elderly: age and gender differences. British Journal of Nutrition. 2002;87(2):177-86.
26. López-Ortega M, Arroyo P. Anthropometric characteristics and body composition in Mexican older adults: age and sex differences. British Journal of Nutrition. 2016;115(3):490-9.
27. Gardasevic J, Rasidagic F, Krivokapic D, Corluka M, Bjelica D. Stature and Its Estimation Utilizing Arm Span Measurements in Male Adolescents from Federation of Bosnia and Herzegovina Entity in Bosnia and Herzegovina. Montenegrin Journal of Sports Science & Medicine. 2017;6(1).
28. Arifi F, Sermaxhaj S, Gardasevic J, Alaj I, Metaj Z. Stature and its estimation utilizing arm span measurements of both gender adolescents from southern region in Kosovo. Sport Mont. 2018 Jun 1;16(2): 51-4.
29. Supare MS, Bagul AS, Pandit SV, Jadhav JS. Estimation of stature from arm span in medical students of Maharashtra, India. Annals of Medical and Health Sciences Research. 2015;5(3):218-21.
30. Gupta C, Palimar V, Guru P. Estimation of stature from the arm span of an individual in South Indian population. Annals of Bioanthropology. 2016;4(1):17.
31. Dorjee B, Sen J. Estimation of stature from arm span, arm length and tibial length among Bengalee. Human Bio Review. 2016;5(2):128-45.
32. Esomonu UG, Ijomone OM, Mba C, Oranusi A. Estimation of stature using arm span length amongst Bekwara ethnic group of Cross River State, Nigeria. Annals of Bioanthropology. 2015;3(2):55.
33. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimation from foot dimensions. Forensic Science International. 2008;179(2-3):241-e1.
34. Ozden H, Balci Y, Demirüstü C, Turgut A, Ertugrul M. Stature and sex estimate using foot and shoe dimensions. Forensic Science International. 2005;147(2-3):181-4.
35. Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: an indigenous population of North Bengal. Forensic Science International. 2008;181(1-3):55-e1.

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