ORIGINAL ARTICLE

Estimation of Stature Using the Clavicular Length of Adults in South-Eastern Nigerian

Ukoha U Ukoha[1], Chijioke M Okeke[1], Chinwe Ukoha[2], Jervas Ekezie[3], Kelechi R Onyenankeya[4]

Authors' affiliations: [1]Lecturer, Dept. of Anatomy, Nnamdi Azikiwe University, Awka; Lecturer, Dept. of Microbiology, Chukwuemeka Odumegwu Ojukwu University, Uli; Lecturer, Dept. of Anatomy, Federal University of Technology, Owerri; Post graduate, Dept. of Anatomy, Nnamdi Azikiwe University, Awaka

Correspondence: Chijioke Okeke, Email: okeke.chijioke@yahoo.com, Mobile No.: +2348030465528

ABSTRACT

Background: Estimation of stature from the clavicular length is utilized in anthropological research and in forensics for identification of mutilated bodies. The aim of this study was to assess the relationship between stature and clavicular length in South Eastern Nigeria.

Materials and Methods: One thousand subjects (500 males and 500 females) aged 18-35 years were studied. The subjects were grouped into group1 (18-24years), group 2 (25-31 years) and group 3 (>31 years). The length of the clavicle was measured with a Vernier caliper. The values obtained were analyzed with Statistical package for Social Sciences (SPSS) version 20.

Results: There was statistically significant positive correlation between stature and lengths of the right and left clavicle ($p \leq 0.01$) across all the groups in both sexes, with the exception of group 1 in females, where the correlation was not significant. ($p=0.140$). There was significant positive correlation between the lengths of the left and right clavicle ($p \leq 0.01$). There was significant sexual dimorphism ($p \leq 0.05$) in the lengths of the clavicle. A regression equation for males was more reliable than for females in estimating stature from clavicular length.

Conclusion: Lengths of the clavicle may be used to estimate stature in especially in males in South Eastern Nigeria.

Key words: Stature, Height, Clavicle, South Eastern Nigeria

INTRODUCTION

Personal identification is an essential issue when mutilated and amputated limbs or parts of the body are found in mass disasters. Personal identification is one of the major tasks of forensic research.[1] Forensic anthropometry is the analysis of human remains for the medicolegal purpose of establishing identity. It is a specialized area of science that requires detailed anatomical and osteological training. Being able to assign a name to the deceased is critical to the successful outcome of all legal investigation and this becomes increasingly complex as the body passes through the various transitional phases of decomposition.[1] Goals of forensic anthropometry are usually to assist in the identification of humans remains especially with regard to the evidence of foul play which involves the identification of stature, age, ethnicity.[1] And among these, stature is one of the main parameter of personal identification in forensic examination.[2]

Stature estimation occupies a relatively dominant position in anthropometric research.[3] Stature has been one the most important factor in the description of the individual characteristics for a long time.[4-9] The estimation of height from various parameters has been reported in various studies.[10-15] Stature is a unique biological entity that can be estimated not only in the living individual but also from a skeleton long after the death of a person. In order to assess height from human remains, an understanding of it in a living person is crucial.

The human clavicle has been recognized a good anthropometric parameter and has been shown to exhibit sexual dimorphism.[16,17] Clavicular length as an important anthropological parameter is defined as the distance between the lateral-most point of the clavicle in the acromioclavicular joint and the medial-most point of the clavicle in the sternoclavicular joint.

Asides from cases of identification, this research can be helpful for prediction of stature in individuals with disproportionate growth abnormalities and skeletal dysplasia or height loss during surgical procedures on the spine.[18]

Purpose of the study:

The purpose of this study was to investigate the relationship between stature and clavicular length in a south eastern Nigerian population, so as to establish formulae to estimate the stature from length of arm of both sexes in the said population.

MATERIALS AND METHODS

Ethical approval was obtained from the Ethics Committee of the Faculty of Basic Medical Sciences of the Institution. Informed consent was obtained from subjects before measurement was taken. One thousand subjects (500 males and 500 females) from 18–35 years in Anambra State, South-Eastern Nigeria were enrolled into the study. Subjects with fractures or malformation of the clavicle or upper limb were excluded from the study.

The maximal length of the clavicle was measured with a manual Venier caliper (0-150mm *0.05/6"*1/128, Gilson tools Japan), with a precision of 0.05mm. The palpable landmarks for measuring the clavicle were the most medial point of the clavicle in the sternaclavicular joint and the most lateral point of the clavicle in the acromioclavicular joint. The stature of the subjects was measured with stadiometer according to standard guideline.[19] All measurements were taken by one observer to reduce inter observer error. Measurements were taken three times and the mean was taken and was recorded in centimeter.

Data was analyzed with the Statistical Package for Social Sciences (SPSS) version 20 for windows. Independent Sample T- test was used to determine the significant differences between genders. Pearson correlation coefficient was calculated to assess the correlation of stature and length of the clavicle in male and female subjects. Regression formulae were derived to determine stature from length of the clavicle. P value was set at 0.05.

RESULTS

Table 1 shows the demographic and anthropometric parameters of the subjects. The heights of subjects in group 1 were higher than groups 2 and 3 in both sexes. All the anthropometric parameters were higher in males than females and the difference was significant (Table 2).

Table 3 shows the correlation of height and length of the clavicle in both sexes. There was significant correlation of height and length of the clavicle in both sexes and in all age groups with the exception of right clavicular length of females in group 1.

Table 4 shows the regression equations that could be used to calculate height from the length of the clavicle in both sexes.

Table 1: Demographic and anthropometric parameters of subjects

Age group	Parameters	Male(Mean±sd)	Female(Mean±sd)	Total(Mean±sd)
Group 1 (18-24 years)	Height(cm)	170.44±10.19	165.15±7.61	167.53±9.24
Male=190	LCL(cm)	16.96±1.58	16.52±1.35	16.72±1.47
Female=232	RCL(cm)	15.69±1.60	15.41±4.24	15.54±3.32
Group 2 (25-31 years)	Height(cm)	168.96±8.34	164.99±7.23	167.11±8.10
Male=212	LCL(cm)	16.81±1.59	16.52±1.31	16.68±1.47
Female=185	RCL(cm)	15.85±1.67	15.36±1.39	15.62±1.56
Group 3 (>31years)	Height(cm)	169.55±8.28	162.99±7.28	167.49±5.92
Male=98	LCL(cm)	17.33±1.73	16.69±1.40	17.16±1.66
Female=83	RCL(cm)	16.32±1.72	15.51±1.40	16.09±1.68

LCL- left clavicular length;RCL- right clavicular length

Table 2: Sexual dimorphism in the parameters between male and female subjects

Age group	Parameters	Male(Mean±SD)	Female(Mean±SD)	P-Value	Degree of Dimorphism
Group1 (18-24 yrs)	Height(cm)	170.44±10.19	165.15±7.61	0.000	1.8^0
	LCL(cm)	16.96±1.58	16.52±1.35	0.002	
	RCL(cm)	15.67±1.60	15.41±4.24	0.036	
Group 2 (25-31 yrs)	Height(cm)	168.96±8.34	164.99±7.27	0.000	1.6^0
	LCL(cm)	16.81±1.59	16.52±1.31	0.049	
	RCL(cm)	15.85±1.67	15.36±1.39	0.002	
Group 3 (>31 yrs)	Height(cm)	169.55±8.28	164.99±7.28	0.000	1.6^0
	LCL(cm)	17.09±1.98	16.52±1.31	0.011	
	RCL(cm)	16.01±1.98	15.36±1.39	0.004	

LCL- left clavicular length; RCL- right clavicular length

Table 3: Correlation of height and length of the clavicle on both sides.

	Male				Female			
	Height and LCL		Height and RCL		Height and LCL		Height and RCL	
	Coefficient (R)	P-Value	Coefficient (R)	P-Value	Coefficient (R)	P-Value	Coefficient (R)	P-Value
Group 1 (18-24 yrs)	0.521*	0.00	0.474*	0.00	0.358*	0.00	0.098	0.140
Group 2 (25-31 yrs)	0.554*	0.000	0.522*	0.000	0.446*	0.00	0.434*	0.00
Group 3 (>31yrs)	0.778*	0.000	0.773*	0.000	0.499*	0.000	0.605*	0.000

LCL- left clavicular length; RCL- right clavicular length

Table 4: Regression equations for estimation of height from length of clavicle of male and female subjects

Age range(yrs)	Male		±see	Female		±see
	LCL	RCL		LCL	RCL	
Group 1 (18-24 yrs)	113.074+2.933	113.074+0.484	8.7	102.292+3.41	102.292+1.550	21.91
Group 2 (25-31 yrs)	120.175+2.3062	120.175+0.632	6.96	131.981+0.41	131.981+1.894	19.18
Group 3 (>31yrs)	113.379+1.833	113.379+1.550	5.11	138.241+(-0.983)	138.241+2.720	17.11

LCL- left clavicular length; RCL- right clavicular length

DISCUSSION

Estimation of stature is an essential part of identification process of unknown individuals, especially in situations where human bodies are found either as skeletal remains or in mutilated conditions.[16] In living subjects, percutaneous length of bones can be used for prediction of stature in different populations and different age groups.[20-25] In the present study, height and clavicular length was evaluated in subjects within the age range of 18–35 years in South Eastern part of Nigeria.

The measured anthropometric parameters in the study were higher in males than females and the difference was significant (Table 2). There was significant correlation of height and length of right and left clavicles in both sexes and in all age groups with the exception of the right clavicular length of females in group 1.Regression equations were generated for calculating height from the length of the clavicle in both sexes. It shows that females have the highest standard of error of estimate (SEE).

Strengths and limitations:

The strength of the study lies in the fact that the sample size used for the study was reasonably large. The measurements were based on living subjects. This may not match measurements obtained from skeletal remains which is ideal in forensic medicine.

Interpretation and implication:

In the present study, the magnitudes of anthropometric parameters in males are higher than that of females. It is known that males have higher skeletal size and body mass [14] and this may explain the above finding. Height in male and female subjects in group 1 has larger magnitude than that of subjects in groups 2 and group 3 (Table 1). This may be due to the age related reduction in height of bones, muscles and joint.[26]

Anthropometric parameters are variable from place to place. It is affected by such factors as genetic, nutrition, geographical location, physical activity and various races. The mean height and length of clavicle in males in the present study were 169.65cm and 16.5cm respectively. These values were slightly lower than, but comparable to the findings of Shahzan et al [27] in male Indians. They reported 170.12cm and 17.02cm respectively for height and length of clavicle.

In a study on correlation of stature of adult with the length of the clavicle of New Delhi population by Yashoda et al, [16] it was reported that the mean length of the left clavicle was higher than the mean length of the right clavicle for both sexes. This was similar to the findings in the present study.In the present study, height had significant positive correlation with length of clavicle in males and females and across all the studied age groups with the exception of group 1 (18 -24 years) in females where the correlation was not significant. Eftekhar et al [28] reported that there was a significant relationship between the length of the clavicle and height for male and female.

A significant gender difference exists at p≤0.05 in height, left clavicular length and right clavicular length of male and female subjects of different age range in the present study (Table 2). This is in line with the findings of Natalie [29] in American population. The degree of dimorphism as reported in the present study was 1.8⁰ (group 1) and 1.6⁰ (Groups 2 and 3). This finding is in accordance with studies carried out by Alcina et al [17] to determine if sexual dimorphism exists in the clavicle of modern Spanish population.

The regression equation and standard error of estimate (SSE) shows that the females have the highest SEE (Table 4) and this is in agreement with a research carried out by Ekezie et al.[30] in which they

noted that such a high value of SEE would exclude the clavicle from being used in estimation of stature in the case of females.

CONCLUSION

In the study population sexual dimorphism was demonstrated as the average stature and length clavicle of males were higher than the female counterpart. There was significant correlation between stature and length of the clavicle in male subjects and in most of the female subjects. Stature may be determined from the length of clavicle in male subjects.

REFERENCES

1. Kanchan T, Krishan K. Personal identification in forensic examination. Anthropol [Internet] 2013[cited 2019 June 7];2(1):114. Available from: https://www. omicsonline.org/personal-identification-in-forensic-examinations-2332-0915.1000114. php?aid=21910

2. Pablos A, Gomez OA, Garcia PA, 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):e1- e54

3. Oria RS, Igiri AO, Egwu OA, Nandi ME. Prediction of stature from hand length and breadth – Anthropometric study on an adult Cross River State population. Ann Bioanthropol 2016;4:12-16.

4. Athawale M. 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 1963;21(2):105-112.

5. Charnalia V. Anthropological study of the foot and its relationship to stature in different castes and tribes of Pondicherry state. J Anat Soc India 1961;10:26-30.

6. Jit I, Singh S. Estimation of stature from clavicles. Indian J Med Res 1956;44(1):137-155.

7. Joshi N, Patel M, Dongre A. Regression equation of height from ulnar length. Indian J Med Res 1964;52:1088-1091

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

9. Shroff A, Vare A. Determination of height from length of superior extremity and its segments. J Anat Soc India 1979;28:53-57

10. Sládek V, Macháček J, Ruff C, Schuplerová E, Přichystalová R, Hora M. Population Specific stature estimation from long bones in the early medieval population at Pohansko (Czech Republic): Applicability of regression equations. Am J Phys Anthropol 2015;158:312–324.

11. Rastogi P, Murali R, Rastogi S. Hand Biometrics-A tool for gender and Stature estimation. Journal of Forensic Medicine and Toxicology 2014;31(1&2):87-90.

12. Ahmed AA. Estimation of stature using lower limb measurements in Sudanese Arabs. J Forensic Leg Med 2013;20(5):483-888.

13. Mahakkanukrauh P, Khanpetch P, Prasitwattanseree S, Vichairat K, Case DT. Stature estimation from long bone lengths in a Thai population. Forensic Sci Int 2011;210(1-3):279.e1-7

14. Akhlaghi M, Hajibeygi M, Zamani N, Moradi B. Estimation of stature from upper limb anthropometry in Iranian population. J Forensic Leg Med 2012;19(5):280-284.

15. Ukoha UU, Umeasalugo KE, Udemezue OO, Asomugha LA. Estimation of stature from cephalic dimensions in a Nigerian population.Rev de Anat Clin 2015;7(1):17-25

16. Yashoda R, Shrabranak KN, Avnish KS, Atul M. Correlation of Stature of Adult with the Length of the clavicle of New delhi population. J Indian Acad Forensic Med [Internet]. 2011 [Cited 2019 June 8];33:3. Available from http://medind.nic.in/jal/t11/i3/ jalt11i3p194.pdf

17. Alcina M, Rissech C, Clavero A, Turbon D. Sexual dimorphism of the clavicle in a modern Spanish population. Eur J Anat 2015;19(1):73-83.

18. Hepper N, Black L, Fowler W. Relationships of lung volume to height and arm span in normal subjects and in patients with spinal deformity. Am Rev Respir Dis 1965; 91:356-362

19. Hall JG, Froster-Iskenus LIG, Allanson JE. Handbook of normal physical measurements. 13th ed. Pg 108. Oxford: Oxford University Press; 1995

20. Shah T, Patel M, Nath S, Menon SK. A model for construction of height and sex from shoulder width, arm length and foot length by regression method. J Forensic Sci Criminol [Internet].2015[cited 2019 June 8];3(1):402. Available from https://pdfs. semanticscholar.org/56f2/b04aaafc7e19307c3285b6d11c938a246303.pdf

21. Moorthy TN, Ling AY, Sarippudin SA, Nik Hassan NF. Estimation of stature from footprint and foot outline measurements in Malaysian Chinese. Aust J Forensic Sci 2014;46(2):136-159.

22. Ragavan S, Chandran M. Stature estimation from hand length and foot length in adults-a regional study in Chennai, Tamilnadu. Indian Journal of Forensic Medicine & Toxicology 2015;9(1):205-211.

23. Kuppast N. Estimation of Stature from Percutaneous Ulna Length. Medico-Legal Update. 2011. 11(2):87-9.

24. Pal DC, Datta AK. 2014. Estimation of stature from radius length in living adult Bengali males. Indian Journal of Basic and Applied Medical Research2014;3(2):380-389

25. Sheikhazadi A, Hassanzadeh G, Mokhtari T, Sheikhazadi E, Saberi Anary SH, Qoreishy M. Stature estimation from percutaneous Tibia height: study of Iranian medical students. Joint and Bone Science Journal 2015;2(2):121-128.

26. Ozaslan A, Iscan MY, Ozaslan I, Tugue H, Koc S. Estimation of stature from body parts. Forensic Sci Int 2003;132(1) 40-45.

27. Shahzan MS, Babu KY, Mohanraj KG. Estimation of stature using clavicle bone. Drug Invention Today 2018;10(2):3066-3968

28. Eftekhar VSH, Elyasi L, Akbari H, Rashidzade A, Zeiai A, Eftekhar VS. Determination of ratio of clavicle bone length to height in men and women 20-30 years old of Kerman. Rehabilitation Medicine 2014; 3(1):8-14.

29. Natalie RS. Age and Sex estimation from the human clavicle: An investigation of tradition and novel methods. United State Department of Justice. 2009. Document number. 227930.

30. Ekezie J, Anibeze CIP, Uloneme GC, Anyanwu GE, Danborno SB, Iwuoha G. Somatometric Evaluation of Long Bones of the Upper Extremity: A Forensic Tool. Forensic Research International Journal 2015;1(5):1-2.