ESTIMATION OF STATURE USING ARM-SPAN OF ADULT FEMALES IN JOS, NIGERIA

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Abstract

Anthropometry is a typical and basic tool of physical anthropology which forms the basis of scientific methods and techniques on which measurements and physical observations on the living as well as skeleton of man are built. In developing countries, this is an essential tool for effective health care delivery as well as in forensic medicine. This research was aimed at determining if there exists a relationship between the standing height and the arm span of adult females in Jos and to derive equations that will be used to predict these parameters, one from another. With these equations the height of a young adult female can be predicted in conditions where height cannot be measured.

This was a cross sectional study which examined the relationship between the standing height and arm span of 152 apparently healthy, randomly selected, consenting adult female students who fit the inclusion criteria. Measurements of standing height as well as arm span were taken using standardized methods and instruments and data collected was analysed using NCSS/ PASS 2006 Dawson Edition, USA.

Mean age of the subjects was 23 ± 4 years. Mean standing height was 162.4 ± 6.4cm while mean arm span was 174.0 + 8.2cm. Correlation regression analyses done showed that arm span could predict height in females by 99.7% i.e. R^2 = 0.997 ($P<0.05$) and height could predict arm span by 99.7% (R^2 = 0.997) and regression equations were derived to predict height from arm span and vice versa for male adults in Jos. The findings of this study will be beneficial to health care professionals as well as forensic scientists and other stakeholders in the judicial system and as such, it is recommended that further similar research be carried out in other parts of the country.

Key words: anthropometry, female, height, arm span, correlation

Introduction

Anthropometry is described as a typical and basic tool of physical anthropology, which provides the scientific methods and techniques for estimating the various measurements and the observations on the living as well as skeleton of man. Ogunranti [1] also describes anthropometry as the study of the variations that occur in measurable parameters to the human topography which be used to access growth and development in children, including variations in adults, especially as it relates to racial and or ethnic differences. Generally, variations measured in

anthropology are those controlled by polygenic inheritance factors. Thus, the simplest of the parameters in anthropometry include height and weight which vary from community to community in mean values and from tribe to tribe. Height, like other phenotypic traits, is determined by a combination of genetic and environmental factors. Attributed as a significant reason for the trend of increasing height in parts of Europe are the egalitarian populations where proper medical care and adequate nutrition are relatively equally distributed. [2] On the other hand under-nutrition and malnutrition as well as inadequate medical care, seen in developing countries are associated with stunted growth.

While an above average arm-span (reach) is advantageous in sports (such as basketball, boxing, swimming), any decrease in height will cause an increase in the ratio of arm-span to height. This variation may sometimes be an indicator of a health problem. Information obtained from the measurement of height is important in many settings and disciplines including the fields of science, humanities and art. Stature measurement is required the evaluation of children's growth, calculation of nutritional indices of children and adults, prediction as lung volumes, muscle strength, glomerular filtration, metabolic rate, tailoring of drug dosage in patients, [3] determination of basic energy requirements, standardization of measures of physical capacity and for adjusting drug dosage. [4] However, in some individuals with conditions that affect the limb such as in amputees and those with limb deformities, the exact height cannot be determined and so an estimate of the height calculated based on other body parameters is required. These estimations are also of prime importance in predicting age-related loss in stature, identifying individuals with disproportionate growth abnormalities and skeletal dysplasia or height loss during surgical procedures on the spine. [4] These measures are also very important in normalizing pulmonary function in scoliosis. [5]

The measurement of height is also vital in forensic medicine which is which is a branch of medicine that has a specifically legal purpose. Forensic anatomy is a new emerging field which tries to examine and identify preserved and unpreserved body parts of human remains upon which the big fours guiding forensic anthropology are established. The need to establish the identity of dismembered human remains arise from time to time in cases of mass disasters like terrorist attacks, mass murders, transport accidents, tsunamis, floods and earthquakes. Nigeria, the most populous country in Africa has its own share of mass disasters especially man made but despite the current understanding of global best practices concerning medico legal investigation of death resulting from mass disasters, it would appear that Nigeria lags behind. [6] Consequently, Nigerian forensic pathologists who have to investigate these cases have

no Nigerian guidelines to go by, but have to rely on foreign data. [6] This study's objectives were to ascertain the relationship between standing height and arm span, and to derive equations that can predict height and arm span, one from the other among adult females in Jos.

Materials and Methods

This was a descriptive cross-sectional study carried out on 152 randomly selected, consenting female students of the university of Jos aged between 18 and 55. Subjects with physical deformities involving the spine and the limbs were excluded from the study. Subjects that were below the age of 18 years were also excluded because they are still growing, so also were those above 55 years of age since they are likely to have degenerative disorders of the joints. The age of subjects was obtained based on the ages they indicated while obtaining consent. Every subject was measured and included only once so that a pure cross-sectional set of data was constructed. For each subject the age, sex, arm span and standing height were recorded. Age was calculated in completed years at the moment of the data collection.

The height of the subject was measured between the vertex and the floor, when the person is standing erect, in an anatomical position and the head in Frankfort plane, using a stadiometer to the nearest 0.1cm. The arm span measurement was taken with a tape rule from the tip of the middle finger of the right hand to the sternal notch (half arm span). This measurement was taken with the subject standing with the back flat against the wall and both arms abducted to 90 degrees, and with the elbows and wrists extended and the palms facing directly forward. Readings were taken twice to the nearest 0.1 cm, the average obtained and then multiplied by two (2) to obtain the total arm span. These measurements were taken according to International Society for the Advancement of Kinanthropometry (ISAK) 2001 guidelines.

Statistical analyses were performed using Number Cruncher Statistical System (NCSS/PASS 2006 Dawson Edition, USA). Means, standard deviations and standard errors of mean were determined and regression analyses were carried out on the parameters measured.

Results

A total of 152 young adult females were studied for estimation of height from arm span measurements. The mean age of the subjects was 23 $\pm$ 4 years with minimum age being 18 years and maximum 49 years. Table 1 shows the descriptive statistics of the measured parameters. Mean height obtained was 162.4 ± 6.4 centimeters while the mean arm-span was 174.0 ± 8.2 centimeters.

Table 1: Distribution of arm span in females showing mean, standard deviation and standard error of mean with corresponding height in centimetre.

Height (cm)	Frequency	Mean Arm Span (cm)	Standard deviation	Standard Error of mean
150 – 154	20	163.8	3.8	0.8
155 – 159	29	169.7	5.2	1.0
160 – 164	50	174.4	4.7	0.7
165 – 169	28	178.4	5.5	1.0
170 – 174	20	184.2	6.4	1.4
175 – 179	5	188.8	4.3	1.9
TOTAL	152			

Mathematical modelling of female height data plotted against mean arm span demonstrated that the best-fit regression model (figure 1) to describe the relationship between arm span and standing height was the linear equation y = 1.012x - 14.17 with a correlation of determination of R^2 = 0.997 (P < 0.05) where y is the height in centimeters and x is the arm span in centimeters. This means that arm span could predict the height of females in Jos by 99.7%.

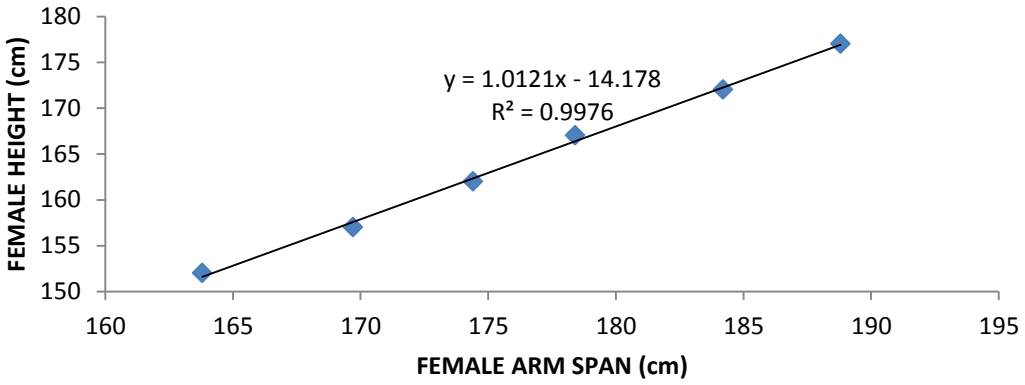

Figure1: Correlation and regression graph showing female height plotted against female arm sapn.

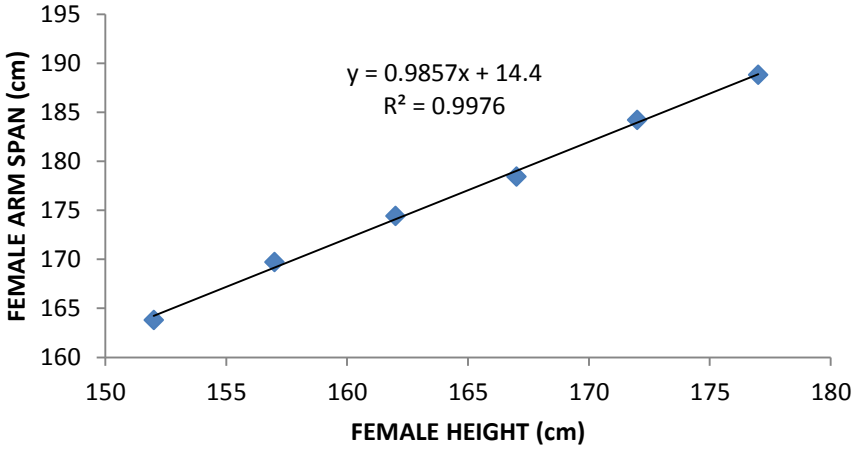

Figure 2: Correlation and regression graph showing male arm span plotted against male height.

On the other way round, when arm span is plotted against height (fig 2) the best mathematical model to describe the relationship was the linear equation $y = 0.985x + 14.4$ with a correlation of determination of $R^2 = 0.997$ ($P < 0.05$) where y is the arm span in centimeters and x is the height in centimeters. This means that height could predict the arm span of females in Jos by 99. 7% ($R^2 = 0.997$) in 152 females in this study.

Discussion

The specific aim of this study was to find out whether there exists a relationship between the arm span and the height of young, adult, female Nigerians. Documentation of research done on this subject and their findings are available from other parts of the world, but none has been documented in Jos, Nigeria. Stature and its determination are necessary and valuable tools in art, forensic medicine and more importantly in health care.

It is useful to health care givers for calculating drug dosage for treatment, as well as for monitoring growth and other health indices. To artists it is useful in determining body proportions. And to forensic anatomists and morbid anatomists, it is important to be able to determine height of victims of crime with dismembered body parts or those burnt beyond recognition, for identification when solving crimes.

In Nigeria, apart from sparse, somewhat inconsistent records of finger prints (dermatoglyphics), there are no known legislative and or legal practices that optimally harnesses the wealth of knowledge and abilities of forensic experts. Nevertheless, recent happenings like increased intertribal and religious wars, political assassinations, secret cult killings, deaths due to road traffic accidents, and the like, point to the fact that time has come for Nigeria to employ forensic experts in the reconstruction of statures of affected individuals. [7]

In many of these cases where height cannot be determined, it must be estimated using another parameter / body index such as the arm span. This can only be done by use of an equation/formula that relates height and arm span. The findings of the present study have confirmed what several other investigators [3, 4, 8-10] reported, that arm span can be used to predict height confidently.

Similar studies were carried out in Benue state Nigeria [3] as well as among the Annang ethnic group of Nigeria. [8] These showed that females mean height ranged from 159.3 – 160.9 cm and mean arm span was from 163.7 – 164.7cm in Benue state, while among the Annang ethnic group, mean stature was 160.66±9.09cm and mean arm-span was 172.22±11.82cm. These values are lower than those obtained in this study and may be due to genetic or environmental factors such as poor nutrition. Also, when compared with the average height and arm span of Montenegrins in similar study, [11] the mean standing height of females in this study is

significantly lower than that of the Montenegrins. There is an assumption that Montenegrins are still the tallest population in Europe. [11] This genetic predisposition for tallness may be responsible for the higher mean values of height in both males and females when compared to those of obtained from this study. Also, European countries are more developed than African ones (such as Nigeria) and have better nutrition and thus better/healthier growth.

In this study, regression equations that can predict the height of a Nigerian female adult from her arm span and arm span from the height were derived. It is necessary to emphasize here that although similar work to this one has been done all around the world and documented, there is yet to be any documented report with regression equations that can predict height from arm span and vice versa, in Nigerian females in Jos. The regression equation obtained for female height determination from arm span was a linear regression equation where $y = 1.012x - 14.17$ with correlation coefficient (R^2) = 0.997. This implies that for every known female arm span (i.e. x), when placed in the equation, the corresponding height (i.e. y) can be determined. The correlation coefficient (R^2) = 0.997 obtained reveals a strong relationship between female standing height and arm span, because the strength of the relationship of the two parameters increase as R^2 (correlation coefficient) approaches 1.

In the analysis where the arm span can be determined from a known value of the height, the graph is positive, showing a strong relationship between the two parameters (female arm span and height) where the correlation coefficient $R^2 = 0.997$. The regression equation derived is a linear equation where $y = 0.985x + 14.4$. Which means that for every known value of female height (x), the corresponding arm span can be determined by substituting that value into the equation.

Conclusion

Height and arm span are basic anthropometric indices which vary with age and population and they are vital anthropometric tools that are very useful in clinical/health management. A strong, positive correlation was found to exist between the two parameters and linear regression equations were derived to predict height from arm span and vice versa. The findings of this novel study will be useful to the anatomists who will attempt to use this data to examine its relevance to the structure and associated functions of other body parts, as well as provide the necessary data for Anthropologists; the Forensic Medical Experts will find the data generated useful in certain forms of human identification in medico-legal cases; clinicians and other health care professionals will find it a handy tool for effective delivery of health care in Nigeria as well as in other parts of the world.

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