ARM SPAN AS A PREDICTOR OF STATURE

Forensic Medicine

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ABSTRACT

"Identification is an individual's birth right". Many characteristics can be used to identify a person. Age , sex & stature are the primary characteristics for the identification of an individual. Stature is an important & useful anthropometric parameter to determine the physical identity of an individual and as such, stature prediction occupies a relatively central position in the anthropometric research. Earlier workers in India have studied percutaneous measurement of different bones of upper & lower extremities or feet measurement alone but hardly any work has been done in correlating the arm span for estimation of stature. The present study has been undertaken with a view to correlate right upper limb measurements with the stature. Analysis is based on the 150 (75 males & 75 females) young & healthy students studying in the SKIMS Medical College & Hospital , bemina , Srinagar , J&K ,India. Regression formulae were constructed for males& females related to the real body height measurement in the erect standard position. The results indicate that the arm span length measurements studied were strongly & positively correlated with stature. In conclusion, the study suggested that estimation of a living height can be made possible by the percutaneous measurements of the upper extremity.

INTRODUCTION

Identification is the determination of individuality of a person living or dead based on certain characteristics. "Identification is an individuals birth right", United Nations Declaration on Human Rights dated 10, 1948[1]. Identification becomes necessary in the living, recently dead persons, decomposed bodies, mutilated & skeleton remains & is required in civil as well as in criminal cases [2]This question forms the basis of identification, Forensic anthropologists have taken interest since a long time in determining the heights of individuals from dimensions of bones. With increasing frequency of mass disasters, identification of an isolated upper extremity and the determination of the stature of individuals have created problems for investigators in identifying victims. However from various studies carried out in different provinces, its been concluded that there is a meaningful relation between the stature & upper limb dimensions[3]. Apart from identification, stature measurement is required for assessment of children's growth [4], calculation of nutritional indices[5], for prediction & standardization of physiological parameters such as lung volumes, muscle strength, resting metabolic rate & for drug dosage.

However, in some cases, measurement of stature is difficult or impossible due to deformities of the trunk or legs, lower limb, fracture/contracture or patient who are unable to stand[6]. Dimensional relationship between body segments & the whole body has been the focus of scientists, anatomists,& anthropologists for many years[7].For this purpose many sets of regression equations have been developed & the better known are Karl Pearson, Troter Glesser from western countries & Pan(1924), Singh & Sohal(1952) & Mehat & Thomas were from India [8]. Previous studies have reported the effectiveness of using various body parameters in estimating stature & Arm Span was found to be the most reliable [9,10]. The earthquake in Turkey in august 1999 and terrorist attack on world Trade Centre in September 2001 created great challenges to identification effort. The present study aims at providing anthropometric correlation of Arm Span with stature.

MATERIALAND METHODOLOGY

The data for the present study was collected by examining 150 healthy students aged 18 to 22in the department of Forensic Medicine & Toxicology, SKIMS-MCH, Bemina, Srinagar,j&k, India. Apart from taking detailed medical history, clinical examination of all the subjects was conducted to rule out any case having any significant disease or deformities, which can affect the general or bony growth. Since the maximum height of an individual is attained between 18 to 22 years, only those individuals were selected for the study.

Equipment: Following standardized anthropometric measuring equipment's were used for various body measurements:
1. Stadiometer
2. Sliding calipers
3. Lukfins retractable measuring tape

METHODS

The aims and objectives of the intended study were explained to the subjects and informed consent was taken on the pro-forma sheet. General physical examination of the subjects was conducted to know the health status and to rule out any deformity, disease,injury in the subjects. To minimize subjective error, all the measurements were taken three times and then mean was taken for statistical calculations. Measurements were taken in centimetres.

STATURE (Standing Height) The height of each subject was recorded by asking him/her to stand erect with bare foot on the base of the standard stadio-meter in a standard standing position i.e.; to stand with both feet in close contact with one another, trunk braced along the vertical board on the stadio-meter with the head oriented in eye-earplane. The face was adjusted to keep the lateral palpebral commissure and the tip of the auricle of the pinna in a horizontal plane parallel to that of the feet. Then the measurement was taken in centimeters by bringing the projecting horizontal sliding bar to the vertex.

LENGTH OF ARM SPAN

Subject were asked to stand upright with weight evenly distributed on both feet, with his/her back to the wall with both arms abducted to 90^0, the elbow & wrists extended & palms facing directly. This was followed by taking the measurements by holding the zero end of the measuring tape at the tip of the middle finger and extend the tape straight to the tip of the middle finger of the other hand & taking the measurements to the nearest 0.1 cm. The above data was tabulated and subjected to statistical calculations and the final result was further analyzed.

Data was analyzed using statistical package for the social sciences (SPSS) version 14(SPSS, including Chicago, IL) means, standard deviation & ranges were used to summarize the anthropometric measurements.

RESULTS

The study conducted showed that there exists a significant correlation between stature and the Arm span, by forming the regression equations, using percutaneous length of Arm span for expeditious administration of law and justice. For this purpose, 150 (75 males and 75 females) young and healthy individuals fulfilling the inclusion criteria between the age group of 18-22 were included. Linear and curvilinear regression equations were formulated for males & females separately & for the total population together.

Stature:

The stature measured by making a person stand in eye ear plane on Stadiometer varied from 166 cm to 185 cm among males with mean value of 172.64 cm and standard deviation (S.D) being 4.99 cm. The stature in females varied from 150 cm to 171 cm with mean value of 160.2 cm and standard deviation being 5.84 cms.

ARM SPAN:

In case of males, Arm span varied from 171 cm to 195 cm with mean value of 177.76 cm and S.D as 5.03 cm. In case of females Arm span varied from 155 cms to 174 cms with a mean value of 163.28 & S.D of 4.677.Linear and curvilinear regression equations were derived separately for the estimation of stature from the length of Arm Span

$S = 33.340 + 0.784 * Arm\ Span$ & r= 0.766 (For total males) & "P" is less than 0.001

$S = -498.5 + 6.602*(Arm\ Span) + (-0.016)*(Arm\ Span)2$ & V=0.775(For total males)

In case of females,
$S = -20.796 + 1.109*(Arm\ Span)$ & r=0.887 & "p" value is less than 0.001 (for total females)

$S = 188.04 + 1.145*(Arm\ Span) + (-0.008)*(Arm\ Span)2$ & V=0.888 (for total females)

'S' is the stature. The positive value of correlation coefficient "r" is suggestive that there exists a direct relationship between stature and length of Arm Span. Calculated statures from these equations are close to the actual height. Multiplication factors were also derived from percutaneous length of Arm Span. The value of (r) was found to be more in case of females ®= 0.887) as compared to that in males (r=0.766), but such a little difference is statistically insignificant.

Table Subjects	Mean height	Mean Arm Span	Avg.corcoeff(r)
Males	172.64	177.76	0.887
Females	160.2	163.28	0.766

DISCUSSION

Various methods are available to estimate stature from human skeletons /percutaneous measurements ,& the most reliable method is by regression analysis.Medical students have been chosen for all the studies conducted so far , as highest cooperation and availability of study population is expected. In the present study correlation of coefficient (r) between stature & Arm span in males is equal to 0.887 & in females is equal to 0.766 which is highly significant.Table below shows the statistical data obtained in the study which suggests a strong correlation between stature & Arm span.

TABLE- Comparison of statistical data for stature reconstruction.

parameter	Gender	Mean (cm)	SD (cm)	Correl coeff (r)	S.E (cm+)	Significance at P<0.05
Stature	Male	172.64	4.99	1	-	-
	Female	160.2	5.84	1	-	-
Arm span	Male	177.76	5.03	0.766	3.195	significant
	Female	163.28	4.677	0.887	2.723	Significant

Regression equations ones calculated can be used to determine measurements (stature or Arm span) , which may be practical use in medico-legal investigations & in anthropometry. Multiple regression equations resulted in better results when compared with simple regression equations. Females were found to have lower lower SEE in all equations compared with males , which can be attributed to wider variability in male size compared to female size. Trotter & Gleser in 1958 provided equations for estimation of stature from long bone lengthsin American White , Black ,Mongoloid & Mexican Males[11]. Allbrook 1961 explored living population of British & East African Males. Many authors have contributed towards the problem of stature

estimation from long bones & include Genoves in 1967 , George K, Neuman in 1967 , Shitai in 1983 .Manpreet Kour , Anupama & others in 2011 measured the height & upper arm length (left side) of individuals having age group 17-25 among North Indians, & suggested that there exists a positive relationship between stature and upper limb length. Estimation of stature of an individual from skeletal material or from mutilated limbs has obvious significance in personal identification in events of murders, accidents or natural disasters mainly concerning with Forensic identification analysis. Ilayperuma et al(2009) , Jsuja (2004). Stature upper arm length for estimation of stature has been attempted by various workers. Study conducted by Nath , Garg and Krishan(1991) for estimation of stature through percutaneous measurements of upper & lower limbs among 160 male Rajputs of Dehradun in age group of 16-35 years and they were measured for upper arm length along with other parameters .Akhlag M,Hajibeygi M,Zamani & Moradi B, in 2010 , presented regression for determining height from upper limb (left side) on 100 right handed Iranian medical students aged between 21-26. Correlation of coefficient ranged from 0.310 to 0.696 in males and 0.290-0.735 in females. The highest correlation coefficient between stature & foot length in males & foot breadth in females indicates that the foot length provides the highest reliability and accuracy in estimating stature of unknown male & female [12].The analysis of fleshed bodies and body parts is also a common scenario. For stature estimation in these types of cases, anthropometric data provides a good result and removes the necessity for the dissection when worked with fleshed body portions[13]. A relationship between stature &arm span or forearmulnar length was found in Chinese children and adults ; total of 656 subjects were studied(512 children- 248 boys & 264 girls & 144 adults-60 men ,84 women), was found to be significant [14].

CONCLUSION

The study indicates that the stature can be predicted accurately by linear/curvilinear and multiple regression analysis even when identity is unknown from Arm span. In mass disasters, terror events, bomb explosions , accidents , wars , etc., identity of an individual can be estimated when only some remains of body are found. If either of the measurement is known , the other can be calculated & this would be useful for forensic medicine experts & anthropologists. It will also help in establishing identity in certain civil cases. There are lot of variations in estimating stature from limb measurements among people of different region & race. Hence there is a need to conduct more studies among people of different regions and ethnicity , so that stature estimation becomes more reliable and identity of an individual is easily established. These regression equations can be routinely used for the estimation of stature from the fragmentary remains & therefore will be of immense importance in the field of crime detection. Intact long bones of upper and lower extremities have been used in the derivation of regression equations for the estimation of stature in different population groups 15.

CONFLICT OF INTEREST: None

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