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Estimation of Stature from Different Methods

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Abstract:

In the cases of mass disaster, mass fatality, and others, the identification of the person becomes difficult and challenging task for the forensic experts, anthropologist and medical experts. For the identification, there are many variables such as sex, age, race and stature of the person can narrow down the area of search. In these variables, stature also plays an important role in establishing the individuality of the unidentified person throughout the large fatalities. This paper reviews the different methods of stature estimation in which the correlation between stature and foot length, ring and index finger, right middle finger etc. and try to find out the significant correlation between bones and stature. All bones with stature show the correlation on the basis of regression equations.

Keywords *– Stature, Fatalities, Regression Equation*

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Introduction

Anthropology is dealt with the human being and is extensively used in the forensic identification. In this forensic identification, sex, race, stature and age of the person are determined. These features are used for the personal identification of person. Among these four features, stature is also most important feature. The determination of stature of deceased through the use of skeletal remains has become important evidence in the court of law. The stature of deceased is estimated in both cases criminal, and disasters where mass fatalities are found. Mass fatalities means the occurrence of death in the bulk due to accident like disaster, disease and war.

Stature refers to the height of dead body in standing position. Many researchers worked for this through which different methods have been established for the estimation of stature. As in 1899, Karl Pearson stated the regression equations for the determination of stature which were basically based on the population. Regression equation or formula is the equation that show the relation between two or more variables. In these variables, one is dependent variable and another one is independent variables.

After that many other methods were developed in this field. Through the estimation of stature, the anthropologist would be able to narrow down the identification during investigation. There are two methods for the determination of stature in forensic cases; anatomical and mathematical techniques. The relation between the stature and different body parts measurements were recognized by the researchers. Before making any decision, it is necessary to consider the other factors such as race, age and sex which impact the result as these factors vary according to the population as well as environment **(Kamal and Yadav, 2016; Vardhan and Pandey, 2016; Verma and Mahmood, 2015)**

Review of Literature

The identification of stature from foot length:

In 1968, **Kulthanan et al, Ozden et al, Rutishauser and Philip et al** were the scientist who studied about the relation between the height of body and the foot length which is more reliable compare to the long bones. The foot is ossified and matured earlier than the long bones. So, at the time of adolescence age, the height can be estimated accurately from the foot measurements rather than the long bones. The regression equations were formed to find the correlation among the foot measurement and stature of an individual. Rakhee Verma and Syed Mahmood tried to find this correlation in 2015. They conducted their study at Community Medicine Department in which 150 students were taken as samples (no disease or deformity person was involved). These 150 students had the age ranging from 17 to 25 years.

The distance was measured from proximal point of heel to the tip of hallux or tip of the toe in case of longer toe than hallux by the use of caliper in centimeter. The height of an individual was also measured in standing position through the same instrument. After the collection of data, Karl Pearson's correlation coefficient and regression equation were applied to find the connection between foot length and stature of an individual. Through the analysis, they concluded that there is a storng relation between the foot length and stature of both female and male. The use of foot length in the estimation of stature is reliable and accurate in both cases male and female.

Regression equation for foot length:
For Males
Y = 88.39+3.27 RFL
Y = 92.81+3.32 LFL
For Females
Y = 81.29+3.32 RFL
Y = 80.90+3.34 LFL
Where
Y = Total height
RFL = Right Foot Length
LFL = Left Foot Length

Estimation of stature from index and ring finger

According to the Kerley, each body part has a relation with the stature. In the earlier studies, numerous hand measurements are used to differentiate between the ethnic groups. But the drawback of these studies was, one formula was applied only one population, not other population. There are many studies for calculating the stature from foot length, limb length and long bones but few are based on the hand and finger lengths. Raju, Shahina, Dubey and Vijayanath in 2014 studied about the estimation of stature from index and ring finger length of right hand. This study was conducted in the department of forensic medicine and toxicology at SSIMS in which 250 subjects were taken who were freed any skeleton deformity. The anthropometric measurements of index and ring finger were measured along with the height of an

individual. The data of all 250 subjects were collected and analysed through Statistical Package for social Sciences (SPSS) for finding the correlation between stature and index and ring finger length. The regression equation, SEE, P value, and r square were applied for the estimation. The P value was found 0.001 for index and ring finger in both case males and females. The estimated regression equation for the stature:

Males:
Y1 = 129.84+5.81 (RIFL) ± 8.8
Y2 = 96.44+10.14 (RRFL) ± 8.8
Females:
X1 = 111.32+7.10 (RIFL) ± 9.2
X2 = 120.59+5.53 (RRFL) ± 11.8
Where:
RIFL - Right Index Finger Length
RRFL - Right Ring Finger Length

Through these regression equation, Right finger length (RFL) with high significant values can be used to estimate the stature in the population of South Indian. These equations can be used when only amputated part is available and other parts are not present. According to the study, it was concluded that the equation can narrow down the pool of victim matches in victim identification cases.

The determination of stature through right middle finger measurement

Shivakumar, Raju and Vijaynath studied about the correlation between the stature and the right middle finger measurements in 2013. For their study, they took the sample of 100 males having the age between 17 to 22 years. The individual's height was measured through standard anthropometer while the measurements of right middle finger was taken through the use of sliding caliper. In the outcomes, it was estimated that there is significant correlation between the stature and right middle finger length measurements among the South Indian Population. The regression equation for the stature estimation through right middle finger measurement is;
S = 152.02 + 147X
Where X is Right Middle Finger Length (RMFL)

Estimation of stature from scapular measurements

In their paper, **Igwe and Akpuaka** tried to find out the relation between the scapular measurements and stature of individuals of south-east Nigeria. Before Igwe and Akpuaka, Many researcher worked on the population of Italy and America to derive the linear regression equation for the estimation of stature.

In their study, they used the measurements of scapula bones given by Campobasso et al in 1998. They selected the samples as the patients in the University of Nigeria. Total 90 samples that comprised 45 males and 45 females having the age from 25 to 65 were taken. Six different variables of scapula were measured through spreading caliper. The height of individuals were also measured through standard height measuring instrument in the erect position. These are the six scapular measurements; Maxim urn length of scapula (MLS), Maximum Breadth of scapula (MBS), Length of coracoid process (LCP), Length of glenoid fossa (LGF), Breadth of glenoid fossa (BGF) and Length of axial border (LAB).

Table: Linear regression equations to estimate the stature in female Igbos of south east Nigeria

Stature (FH) Liner regression Equatio	Variables
S= 131.232 + 2.264x	Where x=MLS
S= 165.401- 0.716x	Where x=MBS
S= 97.322 + 19.894x	Where x=LGP
S= 213.833 - 15.000x	Where x=LGF
S= 67.935 + 43.785x	Where x=BGF
S= 52945 + 1.145x	Where x=LAB

Table: Linear regression equations to estimate the stature in male Igbos of south east Nigeria

Stature (FH) Linear regression equation	Variables
S= 171.046 - 0.029x	Where x=MLS
S= 149.162 +·3.543x	Where x=MBS
S= 214.212 -12.982x	Where x=LCP
S= 202.481 - 9.062x	Where x=LGF
S= 128.583 +19.167x	Where x=BGF
S= 151.486 +2.225x	Where x=LAB

Through the linear regression formulae, it was found that the maximum length of coracoid process and maximum breadth of glenoid fossa are most useful to estimate the stature in case of female while in the males, the maximum scapular breadth and length of axial border were found suitable with the linear regression equations. These linear regression formulae can be used in the fragment bones for the estimation of stature.

Estimation of stature from mandibular measurements

In 2014, Milanis and Panattoni studied about the stature estimation through the mandibular parameters in which they took 56 individuals of both sexes (20 females having age range from 20 to 65 years and 36 males having age range from 26 to 66 years) of Caucasian Italian population. The stature of each individual was measured by non-stretch, coverable anthropometric tape and also the distance between cephalometric landmarks of both sides of mandibular were measured through digital anthropometric head caliper in which Co-Co (bicondylar distance), Co-Go (Condylion-gonion distance), Go-Go (bigonial distance) and Go-Gn (gonion-gnathion distance) were included.

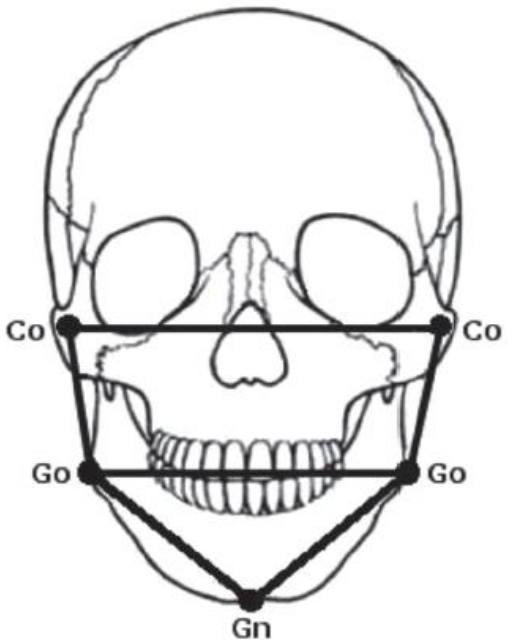

Figure 1 - Distance between Landmarks (Milanis and Panattoni, 2014)

The mandible dimension (MD) is the sum of co-go-gn distances of both sides of mandibular. The relationships between MD and measured living stature (MLS) were used through pearson correlation analysis for the attaining the estimated living stature.

The linear regression equation from MD:
ELS = (3.1843)MD+74.299
R^2 = 0.4761; r = 0.690; SE = 7.399; P<0.05
The estimated living stature regression equation from single distances

Mandibular distances	Equation	R^2	r	SE
Co-Co	ELS=(5.0636) CoCo+105.17	0.139	0.373	9.490
Go-Go	ELS=(7.076) GoGo+98.332	0.232	0.482	8.959
Co-Go	ELS=(8.650) CoGo+119.57	0.287	0.536	8.635
Go-Gn	ELS=(9.720) GoGn+80.693	0.405	0.636	7.888

SE, standard error; Co-Co, bicondylar distance; ELS, estimated living stature; Go-Go, bigonial distance; Co-Go, condylion-gonion distance; Go-gn, gonion-gnathion distance.

After their study, they concluded that the data is moderate to show the correlation between the mandibular measurements and stature but some researchers stated that there is low significant relation between mandibular morphology and stature. The differences between two statements may be due to the numerous factors that affects the growth of mandible.

Conclusion

According to many studies, each part or bone of the body plays a significant role in the determination of stature. This paper reviewed the many methods of stature estimation such as through foot length, tibia length, scapular measurements mandibular measurements, right middle finger etc. All researchers worked with the linear regression equations for finding the correlation between the statures and bones, and in their conclusion they stated that the single bone is significant to determine the stature even the bone is present in the fragmented form. Through the study, it is also estimated that these methods for the estimation of stature are not applicable for all population as some show the irrelevant result with these formulae. So, there is need to more skill to find the stature of individual through single bone.

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