ESTIMATION OF STATURE BASED ON ARM SPAN, VERTEX OF HEAD TO UPPER LEVEL OF SYMPHYSIS PUBIS DISTANCE AND SUPRASTERNAL NOTCH TO UPPER LEVEL OF SYMPHYSIS PUBIS DISTANCE IN ADULT BENGALI POPULATION-AN AUTOPSY BASED STUDY.

Medical Science

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ABSTRACT

Stature or Body length is one of the important data for forensic identification. Measuring the length of the dead body is a routine procedure in almost all autopsy centres and the procedure is very simple. But the problem arises with mutilated or segmented body parts. Estimation of stature from length of different body segments by multiplication of the same by a known factor has been advocated by almost all text books of forensic medicine but in practical situations these calculations are found to be inaccurate when applied to Bengali population. In the present autopsy based study on Bengali population (n=122, male=80, female=42), measurements are taken of arm span, suprasternal notch to symphysis pubis, and vertex to symphysis pubis distance and the accumulated data are statistically analysed to develop working formulae for calculation of stature from the said body segment measurements.

KEYWORDS

Stature, Arm Span, Vertex-Symphysis pubis distance, Suprasternal notch-Symphysis pubis distance.

INTRODUCTION:

Stature or Body length is one of the important data for forensic identification. Measuring the length of the dead body is a routine procedure in almost all autopsy centres and the procedure is very simple. It is said to constitute one of the "Big Four" traits of identification, other than race, age and sex (gender). Anthropometric techniques and formulae commonly used by anthropologists and adopted by medical scientists and forensic pathologists have been employed to estimate body size or stature for over a hundred years. Estimation of stature from length of different body segments by multiplication of the same by a known factor has been advocated by almost all text books of forensic medicine. These calculations are supposed to give an approximation to actual stature and are in practical use since a long time in the mortuaries of our state. The autopsy surgeons prefer to take help of these calculations particularly when they have to deal with dismembered dead bodies and fragmented body parts, as are encountered commonly in circumstances like railway accidents, road traffic accidents, grossly decomposed bodies and sometimes in cases where the dead body has been dismembered following homicide. But the actual references of these calculations and formulae are not found in the text books and available literature. Most probably these calculations and formulae were derived from anthropological observations on European subjects and as such they are found to be grossly inaccurate and far from a close approximation when applied in cases of Bengali subjects. To our knowledge no such study are available in Bengali population. Therefore the present study has been designed to generate data from which equations or formulae can be derived for reliable stature estimation of the Bengali population and the outcome results will be of great help in the field of forensic medicine and forensic pathology.

AIMS AND OBJECTIVES:

1. To measure the actual length of the dead body.
2. To measure- the span of outstretched upper limbs, the length between vertex of head and upper level of symphysis pubis, and the length between suprasternal notch and upper level of symphysis pubis in the dead body.
3. To calculate the statistical relationship of body length (stature) and above mentioned measurements and to derive an equation/formula from that.

MATERIAL AND METHODS:

Study design: Observational study.
Study period: 6 (six) months.
Study population: All male and female adult dead bodies belonging to native Bengali population and sent to Kolkata Police Morgue for medicolegal autopsy.

Inclusion criteria: All male and female adult dead bodies belonging to native Bengali population and sent to Kolkata Police Morgue for medicolegal autopsy.

Exclusion criteria:
1) Decomposed dead bodies.
2) Dead bodies of subjects having skeletal deformity either congenital or acquired.
3) Mutilated dead bodies (to such an extent that exact measurements are not possible.)

Sample size: Total 122, male-80; female-42.

Study tool and technique: All cases presented during the period of study were considered for study after observing the inclusion and exclusion criteria. Measurements were taken with the help of a steel tape by a single observer on different days, applying standard anthropometric techniques. Body length was taken from vertex to heel with the dead body in supine position. Arm span was taken from tip of one middle finger to that of another in outstretched hands. After locating the suprasternal notch and upper level of symphysis pubis percutaneously (with wooden scales which were held vertically to maintain the same plain to avoid kinking of the steel tape and to minimize human error), suprasternal notch to symphysis pubis and vertex to symphysis pubis lengths were measured with the help of steel tape. The data thus collected were tabulated in MS Excel sheets and analysed using SPSS software.

REVIEW OF LITERATURE:

Anthropometry has enjoyed popularity over the years as a reliable technique to measure human body and its components [1]. In the last half of the 20th century, studies have been more vigorous when skeletal collections have been assembled in many parts of the world. There has been an increase in the frequency of various mass disasters (air and train crash, bombing, mass suicide, flooding, powerful storm). In spite of a need as such, there is a lack of systematic studies to identify fragmented and dismembered human remains [2]. Stature can be reconstructed from the length of bones, particularly the long bones. After the length of the long bones is obtained, one of the sets of published formulae is used to calculate the stature of the person. The famous and age old formulae include those published by Rollet (1888), Manouvrier (1892-93), Pearson (1899), Hrdlicka (1898-1902), Dupertuis and Hadden (1951) and Trotter and Gleser (1951,52,58). The formulae devised by Trotter and Gleser are believed to be the best for general use in estimating stature [3,4]. However these do not help estimating stature in fragmented, mutilated and dismembered dead bodies, during identification at autopsy table. Dimensional relationship between body segments and the whole body has been the focus of scientist, anatomist and anthropologist for many years. Reputed and standard textbooks of Forensic Medicine put forward the

information that if the dead body is fresh the length of the corpse may approximate the stature or height of the subject when living. In case of dismembered body, the height may be ascertained approximately by measurement of the trunk or the limbs as follows-i) the space of the two outstretched upper limbs in horizontal position from the tip of one middle finger to that of the other hand closely equals the person's height, ii) the length from vertex to symphysis pubis if multiplied by 2(two) will give the height of an adult, iii) the length from the suprasternal notch to the symphysis pubis if multiplied by 3.3 will give the stature [5,6,7]. But the actual references of these calculations and formulae are not found in the text books and available literature. Most probably these calculations and formulae were derived from anthropological observations on European subjects and as such they are found to be grossly inaccurate and far from a close approximation when applied in cases of Bengali subjects. To our knowledge no such study are available in Bengali population. In one study on 150 (one hundred and fifty) Bangladeshi Muslim females from Bangabandhu Sheikh Mujib Medical University, Dhaka, the statistical calculations show significant ($p<0.001$) positive correlation between the stature and the arm span [8]. In another study in Maharashtra, India, with 400 medical students (219 males and 181 females) the researchers concluded that mean stature and arm span of male were more than female with statistical significance and stature can be accurately estimated from arm span using simple regression equation or multiplication factor [9].

RESULTS AND ANALYSIS:
Relationship of different (post-mortem) body segment measurements with (post-mortem) body length.

Predictors	Gender-wise effect		Effect of Rigor Mortis		Overall
	Coefficient (P-value)		Coefficient (P-value)		Coefficient (P-value)
	Male	Female	Rigor Mortis Present	Rigor Mortis Absent	
Arm span in cms	0.865 (<0.001)	0.800 (<0.001)	0.874 (<0.001)	0.891 (<0.001)	0.880 (<0.001)
Suprasternal notch to Symphysis pubis in cms	0.618 (<0.001)	0.518 (<0.001)	0.628 (<0.001)	0.517 (<0.001)	0.597 (<0.001)
Vertex to Symphysis pubis in cms	0.465 (<0.001)	0.801 (<0.001)	0.508 (<0.001)	0.732 (<0.001)	0.549 (<0.001)

The above table shows the results of bivariate linear regression analysis into the relationship of the different post-mortem body segment measurements with post-mortem body length. Results of the bivariate linear regression analyses overall indicates that there are significant effects of arm span [$F(1,120) = 413.404$, $p < 0.001$, $R^2 = .773$), distance between supra-sternal notch to symphysis pubis ($F(1,120) = 66.494$, $p < 0.001$, $R^2 = .351$) and vertex to symphysis pubis ($F(1,120) = 51.782$, $p < 0.001$, $R^2 = .296$) on the (post-mortem) body-length. The individual factors are examined and the results indicate that with a change of 1 centimetre length of arm span, distance between supra-sternal notch to symphysis pubis and vertex to symphysis pubis; the body length changes by 0.880, 0.597 and 0.549 centimetres respectively. For male population these values were respectively 0.865, 0.618 and 0.465; however amongst female population the values were 0.800, 0.518, and 0.801 respectively. The gender-wise analyses also recorded satisfactory goodness-of-fit like the overall analyses. It was observed that for those who did not have rigor mortis at the time of study had a better relationship amongst the variables of interest. With an increase of 1 centimetre length of arm span, distance between supra-sternal notch to symphysis pubis and vertex to symphysis pubis, the body length is observed to increase by 0.891, 0.517 and 0.732 centimetres respectively, when Rigor Mortis is absent. The relationship of supra-sternal notch to symphysis pubis distance with body length was better for those with rigor mortis (standardized co-efficient: 0.628, t= 7.093, p <0.001).

To summarize, results show that arm span is the best predictor of height/ stature, amongst the three variables studied with relation, Stature =0.88 x Arm span. This shall be true for 78% of cases. Even when segregating by sex, age, and whether rigor mortis is present or not, this relationship holds true. On the other hand measures like vertex

to symphysis pubis and suprasternal notch to symphysis pubis do not predict the Height/Stature as accurately as the Arm span. Mathematical formulae (Regression equation) to calculate Stature from Arm span, Suprasternal notch to Symphysis pubis distance and Vertex to Symphysis pubis distance have been developed and are follows:
Stature = 36.46 + 0.75 x Arm span
Stature = 1.01E2 + 1.18 x Suprasternal notch-Symphysis pubis distance
E (STANDARD ERROR OF THE ESTIMATE) = 5.98
Stature = 99.27 + 0.79 x Vertex-Symphysis pubis distance

Scattergram of Body length in cms(y) and Arm span in cms(x), showing the Line of best fit (regression line) and regression equation.

Scattergram of Body length in cms(y) and Suprasternal notch to symphisis pubis distance in cms(x), showing the Line of best fit (regression line) and regression equation.

Scattergram of Body length in cms(y) and Vertex to symphisis pubis distance in cms(x), showing the Line of best fit (regression line) and regression equation.
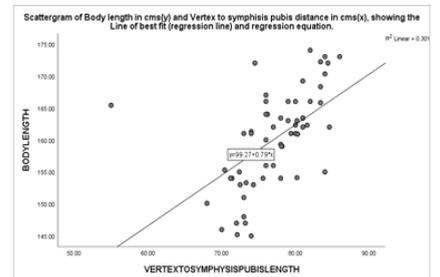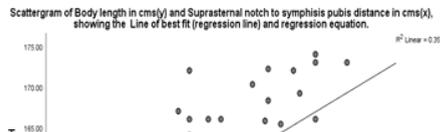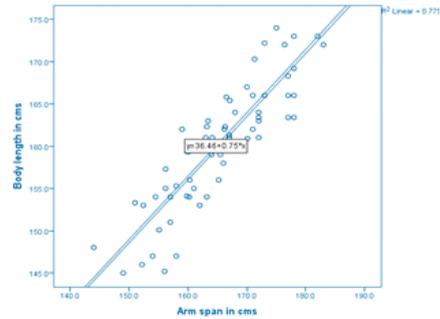
DISCUSSION:
Identification of an individual, living or dead, is a challenging task for forensic experts and physical anthropologists worldwide. At the same time, prediction of stature is one of the key parameters in the identity of victims of mass disasters or fatal assaults, especially in incomplete or isolated extremities, mutilated human remains, and dismembered body segments. Estimation of stature is one of the important parameter in medico-legal and forensic examinations when highly decomposed and mutilated dead bodies with fragmentary remains are brought for post-mortem examination. In this situation, it becomes difficult to identify the deceased. Stature can be estimated from body parameters in dead and mutilated bodies using regression equation or multiplication factor. However, regression equations and multiplication factors are specific for the region only and can't be used in all population. Hence, there is a need of more studies on the estimation of stature from various body parts or body segments in different population groups.

Estimation of stature from length of different body segments by multiplication of the same by a known factor has been advocated by almost all text books of forensic medicine. These calculations are in

practical use since a long time in the mortuaries of our state of West Bengal. But the actual references of these calculations and formulae are not found in the text books and available literature. They are, moreover, found to be grossly inaccurate and far from a close approximation when applied in cases of Bengali subjects. To our knowledge no such study are available in Bengali population.

As such the present autopsy based study was undertaken in Kolkata Police Morgue with 122 adult Bengali subjects (Male-80, Female-42), of which 78 subjects were in the stage of Rigor Mortis. Measurements were taken with the help of a steel tape by a single observer on different days, applying standard anthropometric techniques. Body length was taken from vertex to heel with the dead body in supine position. Arm span was taken from tip of one middle finger to that of another in outstretched hands. After locating the suprasternal notch and upper level of symphysis pubis percutaneously (with wooden scales which were held vertically to maintain the same plain to avoid kinking of the steel tape and to minimize human error), suprasternal notch to symphysis pubis and vertex to symphysis pubis lengths were measured with the help of steel tape. The data thus collected were tabulated in MS Excel sheets and analysed using SPSS software.

CONCLUSION:

All the three parameters studied, namely Arm span, Suprasternal notch to symphysis pubis distance and Vertex to symphysis pubis distance show good correlation with Stature. Arm span is the most predictable of the three. The arm span lengths can be used as a basis for estimating stature and as an alternative measure to stature. Stature can be accurately calculated from Arm span using simple regression equation or multiplication factor. The stature calculation from suprasternal notch to symphysis pubis distance and vertex to symphysis pubis distance are not so accurate, still the regression equations developed with them can be used in circumstances when arm span measurement is not possible, say for example, when a dismembered trunk of the dead body is presented for autopsy and forensic identification.

Conflict of interest: Nil.

ETHICAL CLEARANCE:

Ethical clearance and approval taken from the Institutional Ethics Committee of Medical College, Kolkata.

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