

Relationship between Stature and Arm Span among Adolescent Age Groups

Kamboj Kanwal¹, Sinha Amrita², Pandey Kuldeep³

¹Assistant Professor, Department of Forensic Medicine & Toxicology, Rama Medical College Hospital and Research Centre, Kanpur

²Assistant Professor, Department of Pathology, Rama Medical College Hospital and Research Centre, Kanpur

³Assistant Professor, Department of Forensic Medicine & Toxicology, Autonomous State Medical College, Pratapgarh

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Corresponding author: Dr Sinha Amrita

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Abstract

Background: Generally it is not possible to measure stature of a person because of deformities of the limbs, in person who have undergone amputations or in cadavers where only parts of dead subject are available so stature has to be estimated.

Objectives: Estimation of stature from the arm span among adolescent age groups.

Material and Method: This cross sectional study was conducted on 150 students of adolescent age groups from aged 10-18 years in one of the school of Kanpur City, India during August 2021 to January 2022. Out of 150, 78 were boys and 72 were girls. Analysis was done by using computer based program (SPSS).

Results: Strong correlation between height and arm span which was statistically significant. This was found to be 0.9313 in total subjects, 0.8061 in males and 0.8661 in females. Regression equations were derived and verified on subjects with known parameters using standard procedures.

Conclusion: Arm span is the most reliable body parameter for estimating the height of an individual with high accuracy.

Keywords: Stature, Arm Span, Adolescent, Limb Deformity, Correlation

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Background

Dimension of body size such as height and weight are required for appraisal of growth and nutritional status of person, purpose of basic energy requirements, standardization of measures for physical capacity, for adjust drug dosage and for identifying an unidentified cadaver [1,2].

However, in some situations it is not possible to measure the stature of a person because of deformity of the limbs, in person who have undergone amputations or in unknown cadavers where lower

limb(s) and/or trunk is mutated/absent. In such cases, stature has to be estimated using other body parameters [3-5]. These estimations are also of prime importance in predicting the age-related loss in stature; identifying persons with disproportionate growth abnormalities, skeletal dysplasia, medico-legal cases or height loss during surgical procedures on the spine [6].

These dimensions also have found request in normalizing pulmonary function in scoliosis. Previous studies show that

height can be estimated effectively from various body parameters [7] among all body parameters, correlation between stature and the arm span was found to be the most reliable.

However the relation between arm span and stature is found to vary from race to race. Even though several studies of this nature are available on western populations, this type of study was not done in the areas of Kanpur so this study was planned.

Materials and Methods

It was a cross sectional study was conducted on 150 students of age group 10-18 years in one of the school of Kanpur city, India during August 2021 to January 2022. Out of 150, 72 were boys and 78 were girls, the study was approved by Institutional Ethics Committee. The stature and arm span were measured in all the subjects.

Stature

It was measured with the subject standing on their heels together and back as straight as possible so that heels, buttocks, shoulders and the head touched the wall. The arms were by the sides of trunk with the palms facing the thighs.

Students were asked to take a deep breath and hold it, a measuring steel scale was placed against the head and wall to determine maximum height on the wall and this was marked. The stature was then measured from the floor to the mark on the wall with flexible steel tape which represents the stature in centimeters to the nearest 0.1 centimeters.

Results

Table 1: Descriptive Statistics for all Study Participants (N=150)

| Characteristic | N | Range | Minimum | Maximum | Mean | SD | p-value |
|----------------|-----|-------|---------|---------|--------|-------|---------|
| Stature | 150 | 46.72 | 144.10 | 192.00 | 168.03 | 9.34 | 0.001 |
| Arm span | 150 | 57.40 | 143.10 | 203.00 | 169.52 | 10.41 | |

As per table 1 shows the mean and standard deviations of stature and arm span in total subjects (N=150). The range of arm span was 57.40 and mean was 169.52±10.41 which was found to be statistically significant ($p < 0.05$). This concludes that arm span is the most reliable indicator.

Arm span

It was measured with a flexible steel tape from the tip of the middle finger of one hand to the tip of the middle finger of the other hand with the individual standing with their back to the wall with both arms abducted to 90°, elbows and wrists extended and the palms facing directly forward.

Readings were taken to the nearest 0.1 cm. Measurements was taken twice in each subject. When the two measurements for each parameter fell within 0.4 cm, their average was taken as the best estimate for the true value. When the two initial measures did not satisfy the 0.4 cm criterion, two additional determinations were made and the mean of the closest records was used as the best estimate. The mean values of arm span and height were calculated separately for boys and girls.

Statistical analysis

Data analysis was conducted using SPSS Statistics version 22 (IBM Corporation, Armonk, New York). The data were analyzed using descriptive statistics. Categorical variables were expressed as numbers and percentages. Continuous variables were expressed as mean \pm standard deviation if normally distributed and median with range if skewed. Multiple linear regression analysis was used to determine variables. Prediction equations were developed with study group. For cross-validation of the equations, actual values of height were compared with predicted values using standard procedure A p-value of < 0.05 is considered statistically significant.

Table 2: Comparison of Stature and Arm Span between Boys and Girls

| Variable | N | Range | Minimum | Maximm | Mean | SD | p-value |
|------------------|----|-------|---------|--------|--------|------|---------|
| Stature (Boys) | 78 | 32.11 | 156.80 | 192.00 | 175.91 | 5.91 | 0.01 |
| Armspan (Boys) | 78 | 38.32 | 161.80 | 203.00 | 178.17 | 7.07 | 0.01 |
| Stature (Girls) | 72 | 30.17 | 143.20 | 174.50 | 161.11 | 5.61 | 0.01 |
| Arm span (Girls) | 72 | 39.64 | 142.40 | 182.00 | 162.32 | 6.57 | 0.01 |

As per table 2 shows the mean comparison stature and arm span among boys and girls it was seen both arm span and stature are higher for boys as compared to girls there may be few exceptions but overall it was acceptable and was significant. n

Table 3: Correlation between Stature and Arm Span

| Subject | Correlation coefficient(r) | 95 % confidence interval for r | p-value |
|---------|----------------------------|--------------------------------|---------|
| Total | 0.93 | 0.906 to 0.949 | 0.001 |
| Boys | 0.80 | 0.740 to 0.856 | 0.001 |
| Girls | 0.86 | 0.800 to 0.914 | 0.001 |

As per table 3 there seen a positive correlation between stature and arm span but the relation was more strongly positive in girls as compared to boys. This shows the reliability of arm span as significant indicator. From the analysis of the data, it can also be said that stature can be predicted from arm span with fairly good accuracy as they show significant correlation.

Table 4: Regression Analysis among the Subjects

| Subject | Regression Coefficient | SE | T value | p-value |
|---------|------------------------|------|---------|---------|
| Total | 26.11 | 4.52 | 5.64 | 0.001 |
| Boys | 159.52 | 0.70 | 218.81 | 0.001 |
| Girls | 40.63 | 7.91 | 5.11 | 0.001 |

As per table 4 linear regression analysis of the obtained data has provided a significant prediction of stature and arm span. Regression equations derived from analysis of data are as following:

Total: $Ht = 26.11 + (0.83) As$

Male: $St = 159.52 + (0.09) As$

Female: $St = 40.63 + (0.74) As$

St – Stature in centimeters, As – Arm span in centimeters

Discussion

Stature is a parameter that can be established even in mutilated and dismembered bodies, as well as in fragmentary remains, as can be used for estimation of stature in living subjects also, in whom, it is not possible to measure the stature due to deformity. Estimation of stature using various physical measurements has been attempted by many authors. Chumlea [8] estimated stature from knee height, while Mitchel [4] correlated arm length with stature. The one variable that proved to be consistently reliable in estimating stature was the arm span. Steele and Chenier, in a study on black and white women in the age group

35–89, reported correlations of arm span and stature of 0.852 and 0.903 for black and white women respectively [7].

We observed that males have greater stature than females. This can be explained by genetic constitution of males. Age of puberty being 2 years later in males as compared to females give them additional time for growth. This suggests that the formula for one sex cannot be applied to estimate stature for other sex. The stature found by different authors in India in different region or state is different than the present study [9-10]. Author found mean (SD) stature of male was 168.2 (6.5) and of female was 155 (5.2) and this can

be explained by different genetic constitution, environmental factors and nutrition in different population groups [11].

It has been demonstrated that correlation coefficient between stature and arm span measurements for adult Malawian males was 0.871 and for females was 0.8159. In the present study correlation coefficient between arm span and stature boys was 0.80 and for female was 0.86. 0.989 correlation for white Canadians [12]. 0.903 correlation for white Americans [13] and 0.903 correlation for African Americans has been reported earlier [14]. Strong and significant correlation between the two anthropometric parameters indicated that stature can be predicted fairly accurately from arm span measurements.

Conclusion

Arm span is one of the most reliable body parameter for obtaining the stature of an individual. It is useful in obtaining age-related loss in stature and in identifying individuals with disproportionate growth abnormalities. It also an important parameter medico-legally, where determination of height of subject is a major step in identification of a deceased subject when only parts of the body are available.

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