Is arm span an accurate measure of height to predict pulmonary function parameters?

M. Golshan, B. Amra, M.A. Hoghoghi

ABSTRACT: Is arm span an accurate measure of height to predict pulmonary function parameters? M. Golshan, B. Amra, M.A. Hoghoghi.

Interpretation of pulmonary function tests basically depends on prediction of normal values derived from equations using non-deformed body height. In many patients body height can not be accurately measured. The arm-span method has been used for estimating body height, but the normal relationship between body height and arm span is not exact and differs in various ethnic groups and even between two genders of the same race. In order to minimise the error of estimation of non-deformed body height, the normal relationship between body height and arm span was determined for 754 Persian males and 708 females aged 7 to 82 years, all having normal body stature.

In accordance with earlier reports, two sets of spirometric parameters derived once from height, sex, age; and again from arm-span, sex, age were statistically different, and overestimated when the measured arm-span was used. The body-height/arm-span relationship is described using linear regression equations; in subgroups aging 20 years or less and those older than 20 in different genders. The results indicate significant sex and age differences in the arm-span/height ratio. Two sets of spirometric parameters predicted by real height, sex, age/ and predicted height, sex, age were not statistically different for most of the parameters especially vital capacity.

In conclusion: height estimated from arm span, performs much better than arm span to predict pulmonary function parameters.


Keywords: Spirometry, pulmonary function, lung function, arm-span.

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Introduction

Lung volume and flow rate measurements play an important part of pulmonary assessment both in health and in disease [1]. They are invaluable for providing objective documentation of the presence and severity of a respiratory abnormality, particularly for diseases that are associated with air flow limitation, air-trapping and restrictive changes of the lung [2]. During the last 3 decades lung function tests have evolved from tools for physiologic study to clinical tools widely used in clinical practice [3].

Interpretation of spirometric measurements needs predicted values derived from prediction equations. Almost all equations for prediction of lung function in various populations include standing height, age, and sex as the only variables [3]. The prediction of normal spirometric values requires a measure of the non-deformed standing body height of the subjects. However, several patients referred for pulmonary function testing are unable to stand as a result of physical disability, leg amputation, and other structural defects or neuromuscular weakness. Others have deformities of the axial skeleton which make measurement of height both difficult and inaccurate. Under such circumstances, the arm-span method has been used for estimating the non-deformed body height [4-8]. Height may be estimated from arm span either by application of a fixed correction factor or by using regression equations. Although not absolutely accurate, height obtained by such calculations closely approximates actual height [4-8]. Previous studies have indicated that normal European individuals have only a small difference between height and arm span measurements [9-10]. Anthropometric variability among different races and even ethnic groups has been frequently reported [11], therefore developing local equations is necessary for accurate interpretation of spirometric findings. In our Global village with frequent population movements all physicians should have access to different local equations.

The purpose of this study is to figure out height/arm span relationships in the Persian population of Isfahan and to compare spirometric prediction values derived by; age, sex, height, and age, sex, arm span.

Subjects and methods

The Medical Ethics Committee at Isfahan Medical School had approved the protocols and methods. A population of 1633 healthy subjects, mainly relatives of patients in a pulmonary clinic, and some randomly selected school children and teach-
ers were invited to take part in the study, of whom 1475 subjects or guardians, agreed to be enrolled (response rate = 90.3%). The criteria for inclusion was being able to stand for height measurements and having normal body stature. All subjects were physically examined by a physician; for chest, spine and or limb deformities. Thirteen cases were excluded from the series for the mentioned abnormalities. The remaining 1462 subjects consisted of 754 males and 708 females, aged 7 to 82 years. After recording the name, sex and age, the subject’s height was measured with bare feet pressed against a wall with a right angle, and Arm span was also measured while Subjects were asked to stand with their backs against the wall and arms spread in a straight line parallel to the floor. The metal rule was used to measure from the tip of the middle finger of the right hand to the tip of the middle finger of the left hand across the chest at the clavicles. All readings were taken to the nearest 0.5 cm. All of the measurements were performed twice by two different observers, not looking at each other’s the measurements. The agreement between the two sets was checked and mean of the two measurements was used for prediction calculations.

Spirometric prediction values for various flow-volume maneuver parameters, were calculated using a popular set of prediction equations [12]. Two sets of values based on height, age, and arm span, age were generated for each subject. All data was collected on a database and analysed using a statistical package for the social sciences (SPSS for windows, ver. 11, Chicago Ill).

Arm span/height ratio was calculated separately for both male and female subjects, and used to estimate height from arm span measurements. Since in a pilot analysis; arm-span did not seem to fit exactly with height measurements.

To predict height from; arm span, age, and gender, at first; Two regression analyses were carried out to determine if the measurement of height based on arm span could be enhanced with a prediction equation or by adding age and gender to the prediction equation.

The second analysis was a multiple regression of height on arm span, age, and gender, to determine how much age and gender contributed to the prediction of height. Since the variability of arm span and its correlation with height was greatly differing in different genders and also in different age groups (adults versus children), in a final revision it was decided to develop individual prediction equations for the four mentioned subgroups, therefore male and female subjects were categorized into two subgroups; those aged less than 21 years and those aged 21 years or more, and stepwise multiple regression analysis was used to develop prediction equations to predict more accurate means of height by using arm span in different genders and age groups. The regression models with highest coefficient of determination (r^2) and lowest standard errors of the estimate (SEE) were selected to be reported. Results for the various variables studied were expressed as Mean ±SD, and Standard Errors of Mean were calculated where needed. Comparisons between two groups were carried out using x^2 statistics or paired t test as required.

Results

The anthropometric measurements in various age and sex groups and the mean Arm-span/height ratios are summarized in table 1.

The means of the first and second measurements of height were 157.68 cm (±20.32SD) and 157.41 cm (±19.63) for male subjects and 152.15 cm (±11.56SD) and 152.01 (±11.61SD) for female subjects. The mean absolute difference was 0.20 cm (±0.34SD), the median absolute difference was 0.19 cm.

The means of the first and second arm span measurements were 163.12 cm (±23.41SD) and 163.39 cm (±24.69SD) for male subjects, and, 156.02 cm (±13.89SD) and 156.30 cm (±13.87SD) for female subjects. The mean absolute difference was 0.89 cm (±0.91SD), and the median absolute difference was 0.57 cm. All differences between the two measurements were within 1.5 cm of each other.

The mean absolute difference between height and arm span was 4.83 cm (±5.61SD). The mean

<table>
<thead>
<tr>
<th>Subjects</th>
<th>No</th>
<th>Age Range (Mean±SD)</th>
<th>Height Range (Mean±SD)</th>
<th>Arm span Range (Mean±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males ≤ 20 years of age</td>
<td>478</td>
<td>7-20 (12.77±3.64)</td>
<td>110-188 (148.88±19.92)</td>
<td>110-192 (152.40±21.76)</td>
</tr>
<tr>
<td>Males ≥ 21 years of age</td>
<td>276</td>
<td>21-82 (37.02±12.41)</td>
<td>151-196 (171.56±6.46)</td>
<td>152-200 (179.26±7.64)</td>
</tr>
<tr>
<td>Females ≤ 20 years of age</td>
<td>407</td>
<td>7-20 (13.30±3.50)</td>
<td>113-171 (148.75±13.66)</td>
<td>113-180 (151.45±15.58)</td>
</tr>
<tr>
<td>Females ≥ 21 years of age</td>
<td>301</td>
<td>21-77 (39.50±12.1)</td>
<td>139-171 (156.37±5.75)</td>
<td>142-180 (162±5.92)</td>
</tr>
</tbody>
</table>
absolute differences for males and females were 5.47 cm (±5.82SD), and 4.15 cm (±5.29SD) respectively.

The relationships between measured height and estimated height are plotted in fig. 1. The resultant prediction equations and statistical information are summarised in table 2. Mean and standard deviation of the two sets of the predicted values for pulmonary function parameters calculated by using real height, age, sex and, predicted height, age, sex, are presented and compared in table 3.

Discussion

Arm span has been used as an acceptable measure of body size from which to calculate predicted forced vital capacity and forced expired volume (FEVI) values in elderly subjects who cannot have...
their height measured or who have lost a substantial amount of height. However, this kind of rough estimation of height for pulmonary purposes has been questioned by many authors [1]. In addition, many younger subjects with spinal and/or chest deformities who may need extensive surgical intervention for correction of their deformities will need spirometric parameters in percent of predicted values as an essential part of preoperative evaluation. Accurate measurement of height is not possible in this latter group, nor in most patients with neuromuscular diseases in whom muscular fibers are substituted with more rigid and less flexible structures resulting in thoracic cage remodeling, while both need serial spirometric measurements for monitoring of the progression of their disability.

According to the literature, the majority of evidence supporting the accuracy of arm span as a measure of height has been obtained by studying children and the elderly [13-14]. There is little evidence to support this relationship for young or middle-age adults who may experience acute or chronic conditions that preclude the measurement of standing height. Furthermore most of the published studies comparing height and arm-span have been performed in a small population of subjects [4-7]; a limitation that can hide significant differences.

Rough substitution of arm span for height, to predict spirometric parameters, from equations that have their own errors (standard errors of the estimate), will surely accentuate the errors and will result in significant differences as can be seen in table 3.

Furthermore anthropometric parameters vary greatly in different races, and even local populations [4].

In this study, height, age and arm span of a large random sample of Persians in Isfahan has been used to calculate prediction values of spirometric parameters in different age groups and in both genders. Initially it seems it seems evident that arm-span is significantly different from height, but when statistically analysed, the difference is not significant; a finding which may imply that substitution of them for each other might cause no problem. But when one refers to two sets of derived predicted values based on substitution of these two values, significant difference becomes evident. While spirometric values derived by substitution of estimated height, instead of arm-span, are more accurate values that closely resemble values derived from true-height, age and gender, especially forced vital capacities which have no statistically significant difference in any of the groups.

Surrogating arm span for height to predict lung function parameters; introduces statistically significant errors in Persian people. Substitution of estimated height from arm span, may be preferred in subjects in whom height cannot be reliably measured.

References