Height as a predictor of vital capacity- a spirometric equation for Bengalee footballers

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Abstract

The present study was carried out to evaluate vital capacity of Bengalee footballers, to formulate a prediction equation and to validate applicability of the equation. One hundred and three Bengalee male footballers (17 to 22 years of age) were recruited for study. A stepwise, multiple, linear, regression equation was performed to derive a prediction equation. Validity of the prediction equation was studied using Bland and Altman method of approach for limits of agreement. Mean vital capacity of the subjects was 3382.5 ± 472.9 ml. Difference between the mean (± standard deviation) vital capacity values of direct measurement and predicted vital capacity (PVC = 3383.1 ± 123.7) was statistically insignificant. Analysis of data by Bland and Altman method reveals that prediction equation may be used confidently in place of direct procedure. The regression equation based on height for the studied population is calculated as: Vital Capacity (ml) = 22.25×Height (cm) – 156.16.

Key Words: Indirect method; Lung function; Male; Pulmonary function; Regression equation

Introduction

Spirometric prediction equations are widely accepted in the clinical assessment of spirometry results. Pulmonary function testing measures the function of lung capacity and lung and chest wall mechanics to determine whether or not the patient has a lung problem. However, the required instruments are expensive. Vital capacity is an important index in pulmonary function.

Many studies on vital capacity in the general population have been carried out previously in India (Chhabra, 2009) and abroad (Singh et al., 1993; González-Camarena et al., 1993). A recent study (Chhabra, 2009) was carried out to compare four most widely used equations for the prediction of vital capacity from different regions of India to bring out regional differences and also to evaluate the impact of using these different equations on interpretation of spirometric data. All these prediction equations used in this study were based on height, age and weight of the subjects. It is difficult to establish a national vital capacity norm in a country for healthy men and women as lung function varies with socio-economic (Raju et al., 2004), geographical, environmental (Virani et al., 2001) and nutritional conditions (Zverev and Gondwe, 2001). It is also a well established fact that physical activity improves vital capacity. Alberti et al. (2005) investigated the effect of consistent body exercise on respiratory parameters in smoking and nonsmoking individuals and concluded that exercising has a meaningful relationship with respiration performance. Cheng et al. (2003) investigated the effect of body exercises on respiratory performance test and concluded that active men had higher vital capacity and forced expiratory volume in first one second than that of inactive group. Previous studies have reported important racial difference in measurements of vital capacity so that prediction equations developed in one population may not be appropriate to be used for another population (Barcala et al., 2008). Lung function shows
considerable variation even in normal subjects. The sources of variation in lung function have been summarized by the American Thoracic Society (ATS, 1991). The main independent variables used for spirometric prediction equations are anthropometric measurements such as height, body surface area (BSA), weight. Other anthropometric measurements like sitting heights, sum of skin-fold thickness or measures of muscle strength by dynamometer are also in practice.

In the present study an attempt has been made to evaluate vital capacity of healthy Bengalee male footballers, to formulate a prediction equation and to validate the applicability of the equation.

Materials and Methods

Subjects:

The present study is a cross-sectional study carried out on 103 non-smoking, healthy Bengalee male footballers of 17 to 22 years of age participated in the present study. The subjects were delimited to different regions of West Bengal. A detailed medical history of the subjects was taken and clinical examination was carried out by physician to exclude any disease, mainly respiratory diseases. A verbal consent of all the subjects were taken and they were explained the experimental procedure. An ethical approval to conduct the study was taken from the competent authority.

Physical Measurements:

The age in completed year, standing height in cm was measured with shoes removed, feet together and head in the Frankfort horizontal plane. Weight in kg was measured with shoes and Jackets removed. Body surface area (BSA) was calculated by Du-Bois and Du-Bois Formula (DuBois and DuBois, 1916).

\[
BSA \ (m^2) = (\text{Body mass in kg})^{0.425} \times (\text{Body Height in cm})^{0.725} \times 0.007184
\]

Determination of Vital capacity:

Vital capacity was measured in the standing position with simple spirometer. The subject was asked to stand comfortably, facing the spirometer so that the subject can see the movement of the bell. The subject is asked to inspire as deeply and as fully as possible to fill the lungs. Then while keeping the nostrils closed with a nose clip and the mouthpiece held firmly between the lips, the subject is asked to expel all the air that he can with maximum effort into the spirometer. The forced expiration should be deep and quick but without haste. Three satisfactory readings were taken at intervals of five minutes and the highest among the three was accepted (Chattopadhyay, 2011). The readings were considered satisfactory when the difference between the highest and the next highest vital capacity volume was less than 150 ml (Miller et al., 2005).

Statistical Analysis:

Statistical package for the social science (SPSS) version 16.0 was used for analysis. The results are expressed as Mean ± Standard deviation. Paired t-test, Pearson’s product moment correlation, linear regression statistics and Bland and Altman approach for limit of agreement were adopted for statistical analysis of the data. A stepwise, multiple, linear, regression equation were performed to formulate the prediction equation for vital capacity from anthropometric data.

Results

Means and standard deviations of physical characteristics, vital capacity and predicted vital capacity using the prediction equation of the participants are presented in the table 1.
Stepwise, multiple, linear, regression analysis shows that height is the best predictor for vital capacity (Fig. 1). In this present study, highly significant correlation (p<0.01) existed between the height of the subjects and vital capacity. The following equation, derived on the basis of present data may be used to predict vital capacity in Bengalee footballers.

\[ VC = 22.25 \times H - 156.16. \]

Where

- \( VC \) = Vital Capacity in ml,
- \( H \) = Height in cm.

### Table 1: Physical Parameters, Predicted and Measured Vital Capacity of the Subjects (N = 103)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>17.00</td>
<td>22.00</td>
<td>19.19</td>
<td>0.97</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>150.00</td>
<td>175.00</td>
<td>159.07</td>
<td>5.56</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>44.00</td>
<td>76.00</td>
<td>54.66</td>
<td>6.19</td>
</tr>
<tr>
<td>BSA (m(^2))</td>
<td>1.40</td>
<td>1.83</td>
<td>1.55</td>
<td>0.09</td>
</tr>
<tr>
<td>Vital Capacity (ml)</td>
<td>2700.00</td>
<td>4700.00</td>
<td>3382.5</td>
<td>472.9</td>
</tr>
<tr>
<td>Predicted Vital Capacity (ml)</td>
<td>3181.33</td>
<td>3737.58</td>
<td>3383.1</td>
<td>123.7</td>
</tr>
</tbody>
</table>

Figure 1: Linear regression analysis depicting the prediction of Vital Capacity (VC) from height (Ht) of the Bengalee footballers.
The mean value (± SD) of the vital capacity determined by direct method and the predicted vital capacity using this newly derived equation show no significant variation (P>0.10). The mean difference between vital capacity and predicted vital capacity was -0.58 ml with 95% confidence interval -89.78 to 88.61 ml indicating that the equation predicts the vital capacity within a range of -89.78 to 88.61 ml.

**Discussion and Conclusion**

Various workers have studied the vital capacity values in healthy individuals. There is no such work performed primarily to measure vital capacity of Bengalee footballers. Therefore effort has been made to formulate the prediction equation by different physical parameters of Bengalee footballers by stepwise multiple linear regression analysis. It was found that height was the best predictor to measure vital capacity. This finding is in agree with Indian studies where height was the best predictor to formulate vital capacity (Raju et al., 2005; Virani et al., 2001).

No significant difference is observed (P=0.99) between the values of vital capacity measured by direct method and predicted by newly derived equation. Highly significant correlation (p<0.001) existed between the values of vital capacity measured by direct method and predicted by newly derived equation.

Analysis of data by Bland and Altman method (Bland and Altman, 1986) of approach for limits of agreement between vital capacity and predicted vital capacity reveals that limits of agreement are 912.21 and – 913.38 (fig. 2). These are small enough parameter for the predicted equation to be used confidently in place of direct procedure. Limits of agreement analysis suggest that application of the present form of the prediction equation from height may be justified for the studied population.

Therefore, from the present observations it is concluded that the newly derived equation based on the present data as a valid method to evaluate vital capacity within male Bengalee footballers. However, as this is a pioneer attempt in this population; we recommend the validity of the newly derived equation may be studied in other group of subjects of the same population.

**Key Messages**

* The equation developed on the basis of present data is recommended to be used for the assessment of vital capacity in male Bengalee footballers (17~22 years age).
* This is particularly most useful method when a large number of subjects are to be evaluated without the help of a well-equipped laboratory, in less expense and within a short period of time.
The prediction equation for the estimation of vital capacity of different populations of India may be derived and the same can be used to obtain a reference norm of vital capacity which would be helpful in clinical diagnosis.

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**References**


