PREDICTION EQUATIONS OF VENTILATORY FUNCTION IN NON-SMOKER ADULTS IN ISFAHAN, IRAN

M. Golshan, * M. Nemat-Bakhsh**

Division of *Pulmonary Medicine, Department of **Physiology, Isfahan University of Medical Sciences, Isfahan, Iran

ABSTRACT

Background: Native spirometric standard values are necessary for the interpretation of pulmonary function tests in clinical settings.

Objective: To determine normal prediction equations for spirometric values by measuring lung volumes and flow rates in a sample of healthy non-smoker adults in Isfahan.

Methods: One thousand eight hundred and two healthy adults (955 males and 847 females) with no previous history of smoking were subjected to spirometry and anthropo-metric measurements. Extensive medical interview and physical examinations were undertaken to identify a healthy population. Spirometry was performed using two calibrated instruments. The methodological guidelines of the American Thoracic Society were observed when performing spirometry. Measurements were analyzed and underwent multiple regression to process prediction equations for each spirometric parameter.

Results: The obtained results indicated that the simplest models of prediction equations were those using linear regression of the pulmonary function and the height ($R^2 = 0.88-0.97$) and age without transformation ($R^2 = 0.84-0.93$).

Conclusion: Popular prediction equations in the United States and Europe are applicable to Isfahani adults to predict lung volumes with a minimal over estimation. However, flow-rates are higher in Isfahan and low borderline flow-rates should be interpreted as abnormal.


Key Words • Spirometry • lung-physiology • reference values • spirometry-methods • spirometry-standards

Introduction

Spirometry is the basic pulmonary function test that is widely used to detect air flow limitation1-3 and/or lung volume restriction.4-6 Interpretation of pulmonary function measurements is complicated by the fact that predicted values from the various published studies vary by as much as 20% for an individual subject.7 Thus, a pulmonary function measurement that is below 'normal' with respect to one published reference sample may well be above 'normal' with respect to a different published model.8 In fact, there is not one specific value that is "normal" for an individual subject, but rather a range of values.9 Some variations are due to ethnic differences.4,10 Local and native prediction equations may enhance the reliability of the performed spirometries.11

Test quality remains the most important concern in pulmonary function testing.4,12-14 Variability of consecutive measurements in an individual case is greater in pulmonary function tests than in most other clinical laboratory tests, because of the inconsistency of effort by the patients. The American Thoracic Society (ATS), the European Respiratory Society, and other organizations have published standards designed to minimize the variability in these tests.1

Materials and Methods

During a three-year period from March 1995 to March 1998, patients in a public general clinic were requested to bring all of their family members for medical interview, physical examinations and pulmonary function testing (PFT). Among a total of 2552 adult subjects who were initially invited, 1802
healthy never-smoker adults (955 males and 847 females) were found to be eligible for evaluation. Any of the 2552 participants who had respiratory complaints, history of ever regular smoking, serious cardiopulmonary disease or evident chest deformity were excluded from the study.

The subjects heights were measured in stocking feet against a wall with a right angle. The heights were recorded in centimeters.

All spirometries were performed in the sitting position with a nose clip. The forced vital capacity (FVC) maneuver was performed in a standard fashion as defined by ATS.\(^4\)

The final 1,802 spirometric reports were saved and analyzed with SPSS software using multiple linear regression analysis for each of the measured parameters in relation to sex, age and height of the subjects to predict an equation. The equations were considered to be acceptable if the coefficients of determination (\(r^2\)) were more than 0.80 with \(P\) values of less than 0.05.

## Results

Among the 2552 subjects initially invited for interview 1,802 participants fulfilled the study criteria and their spirometric results were kept for analysis. History of smoking and/or chest illness were the main causes of exclusion of the subjects. Of the 1,802 subjects, 955 were men and 847 women, ranging in age from 20 to 93 years. The age distribution of the population was as follows: 514 were aged 21 to 30, 534 were 31 to 40, 407 were 41 to 50, 195 were 51 to 60 and 152 individuals were older than 60 years. In this adult population, all the measured parameters were positively related to height and negatively related to age. The largest negative correlation with age for both sexes was obtained for FEF 25% of VC and for FEV1. The relationships with height were always linear, while age had an increasingly aggravating effect after forty. The relationships between FEV1 with age are respectively shown in Figure. 1. The extracted prediction equations are listed in Table 1.

## Discussion

Standard reference values are important for both daily needs in clinical medicine, and screening or epidemiologic research conditions.\(^4\) This relatively large-scale investigation provides suitable setting for developing such equations for the Isfahani adults which can possibly be used for other Persian adults. It should be mentioned that many models of pulmonary reference values previously published are questionable\(^8\) for various reasons including the fact that the subject groups included smokers who are not healthy. Only fairly recent studies have restricted their selection of subjects to lifetime non-smokers.\(^4\) Most of the published models have used a constant in their equations, but in our series, use of a constant resulted in a serious decline in coefficients of determination (\(r^2\)), and we decided not to use a constant for most of the equations.

Most of the PFT studies performed in non-European populations have shown greatly reduced lung volumes when compared to European published reference values,\(^4,11,14-23\) a finding which is usually interpreted as indicating greatly lower capacities in populations other than European or white Americans.\(^4,10\) In our series the lung volumes in the Persian population were similar to, or just slightly lower than those extracted from most international scales.\(^4\) More interestingly, the flow-rates in our series are close to the upper limits of western scales.
Prediction equations, which are usually derived from linear regression in adults, do not perform accurately at the edges of data distribution and in those cells where there are few data. The estimates are likely to be misleading if they go beyond the range of the independent variables used to create the equation. Regression analyses are often simplified by restricting the range of possible values to cells (ranges of age and height) in which reasonable predictions are possible. One approach to regression analysis is to use separate simple regression equations for several different age groups. This approach may introduce conflicting estimates at the points of transition between equations. For this reason, we have limited the age groups to two adult groups, younger and older than 50 years. Age 50 has been chosen as the break point since the slope of the FEV1 curve against age significantly changes around age 50.

In conclusion European and/or American standards can be used to predict lung volumes for Iranians, however, only upper limits of the mentioned standards are applicable to our cases when flow-rates are under consideration.

References