Assessment of pulmonary function in local healthy Nepalese men of Dharan and it's anthropometric correlation

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ABSTRACT

Healthy non smoking male subjects (n=150) aged 18-40 years were subjected to pulmonary function testing to establish linear multiple regression model. Pulmonary parameters were considered as independent variables and physical parameters (age, height, weight, body mass index (BMI) and body surface area (BSA) and anthropometric parameters (skin fold thickness (SFT), mid arm circumference and abdominal girth) were taken as dependent variables. This study was undertaken to determine correlation coefficients between dependent variables and different pulmonary independent variables and to derive regression equations or prediction formulae in order to find out the expected normal values for the different lung function tests in a given individual. Present study revealed that the upper body fat distribution, as reflected by biceps skin fold thickness and mid arm circumference, is a significant predicator of ventilatory function.

Keywords: pulmonary function test, prediction equation,

INTRODUCTION

There exist wide gaps in our knowledge of "norms" for Nepalese for different lung function tests used in clinical medicine. A great need, therefore, exists to collect more data on normal population in order to bridge up these gaps in our knowledge. Pulmonary function remains a major biological variable that varies from individual's characteristics to environmental parameters as well as wide variations in socio-economic, geographical, climatic and nutritional conditions. Hence, the study should carry out for building population specific prediction equation rather than using prediction equation built-in in commercial equipment.[1]

Anthropometric measures and age of an individual have direct influence on the pulmonary variables. Therefore, all the prediction equations computed till date have been based on them. The values of different ventilatory functions in healthy persons are known to be influenced by many variables; some of these like racial factor, age, sex and height can be easily evaluated.[2]

Jain *et al* [3] concluded that Vital capacity (VC) have better correlation with height and BSA than age. Further, maximum voluntary ventilation (MVV) shows significant correlation with BSA and height and not with age.

MATERIALS AND METHODS

One hundred and fifty persons age ranging from 18 to 40 years taken from all the sections of the community formed the subjects of this study. They included volunteer members of staff of this institute (BPKIHS), students and healthy relatives of patients accompanying them.

After about 10-15 mins of rest in the laboratory set-up, the physical and anthropometric parameters were measured, such as age, height, weight, BSA, BMI along with abdominal girth, mid arm circumference and skin fold thickness.

Skin fold thickness (SFT) was measured at biceps, triceps, and suprailiac region using skin fold calipers according to the standard protocol.[4] Biceps SFT was taken between the anatomical site of Acromion process and Olecranon process which is also a site for the triceps SFT and mid arm circumference. Triceps SFT was taken at the midpoint on the back of the upper arm located between Acromion process and Olecranon process. Suprailiac SFT was taken at the level of suprailiac crest. The skinfold sites were measured three times and the average results were taken.

Subjects were ensured that nothing restricted the normal chest movement of air flow of the participant during the procedure. They were then instructed to blast all their air into the tube as hard and as fast as they could in one long complete breath. If the subject could not follow all the instructions for the test, they were explained and demonstrated until a satisfactory record was obtained. We made four main acceptability criteria: good start of test, no coughing during the maneuver, no variable flow and no early termination.

The measurement of pulmonary variables as stated above was made by computerized Pneumotachograph (MEDSPIROR, Med System Pvt. Ltd. India). FVC, FEV_1, FEV_3, PEFR and MVV were considered for analysis, since these parameters are mostly used by clinicians to evaluate the respiratory health and to differentiate the restrictive/ obstructive airway diseases. The subjects were asked to perform the PFT at least three times and the best of the three results was considered for analysis of FVC, FEV_1, FEV_3, PEFR. The subjects were always in standing position while undergoing the test. To perform MVV test the subjects were asked to take a deep breath (maximum inspiration) and then to forceful exhale and maximally empty the lungs (maximum expiration) as fast and as strong as possible. The subjects were encouraged to hyperventilate for 10 secs from the beginning of expiration.

Pearson correlation coefficient was calculated to observe the correlation between dependent pulmonary variables and independent physical and anthropometric variables. Statistical information regarding the distribution of the samples were obtained by using ANOVA. A multiple regression model was fitted using lung functions as dependent variables against independent physical and anthropometric variables to formulate the prediction equation and their significance was tested by student 't' test.

RESULTS

Correlation analysis of FVC with different physical and anthropometric parameters showed different relationship (Table-3). There was significant positive correlation with different parameters like height ($p<0.001$), weight and BSA. Whereas negative correlation was observed with age ($p<0.001$), skinfold thickness (biceps, triceps and suprailiac) and BMI.

Height was positively correlated ($p<0.001$) with FEV_1 and other positively correlated parameters were weight and BSA. Further, age, biceps and suprailiac SFT ($p<0.001$) showed statistically significant negative correlation.

PEFR showed negative correlation with age, suprailiac SFT and BMI but statistically significant (–ve) correlation was observed only with age ($p<0.01$). Similar to above pulmonary variables, there was positive correlation with different physical and anthropometric parameters like height ($p<0.001$), weight, mid arm circumference, biceps, triceps, abdominal girth and BSA.

The positively correlated parameters were height ($p<0.001$), weight, mid arm circumference and BSA for MVV. Whereas, negatively correlated parameters were age ($p<0.001$), skinfold thickness (biceps, triceps and suprailiac), abdominal girth and BMI.

The multiple regression analysis was done, taking pulmonary parameters as dependent and physical and anthropometric parameters as independent variables. The constant values and regression coefficient of different independent physical and anthropometric parameters are given in the Table-4. The prediction equations were derived from the regression equation as following formulae:

Predicted value: k $\pm$ (first predictor variable $\times$ coefficient) $\pm$ (second predictor variable $\times$ coefficient) $\pm$ (n^{th} predictor variable $\times$ coefficient).

Where k is constant and the independent predictor variables and their coefficients are taken from regression analysis depending upon their correlation with dependent variables.

All the prediction equations derived have been shown in Table-5.

According to regression analysis done, height was found to be a good predictor for formulating prediction equations of FVC. Besides, age, biceps and mid arm circumference also proved to be predictors for formulating prediction equation with height and mid arm circumference having positive correlation and age and biceps negative correlation ($p<0.001$) (Table-4).

Among the various physical and anthropometric variables, height, age and biceps proved to be the good predictors for calculating FEV_1 (Table 4) with height showing a statistically significant positive correlation with FEV_1 while age and biceps had negative correlation ($p<0.001$).

Regression analysis revealed that only height has the potential to be the predictor for calculating PEFR among the different independent predictors (Table-4). Height was found to have statistically significant positive correlation with PEFR

According to regression analysis, height, mid arm circumference and suprailiac SFT showed as predictors for MVV (Table-4). There was statistically significant positive correlation between height and MVV whereas statistically significant negative correlation between Supra iliac and MVV.

DISCUSSION

The findings show that the use of skinfold thickness in the prediction of pulmonary variables seems to be a practical and useful method. Triceps skinfold thickness provides estimations of subcutaneous fat stores.[5] Skinfold thickness, abdominal girth is used as indicators of a central pattern of fat distribution.[6] Age, height, and biceps SFT all contributed to the prediction equations.[7] Stepwise multiple regression analysis for the normal group was done and revealed the biceps skinfold thickness to be a predictor for most of the pulmonary function tests.[8]

The study showed negative correlation of age with pulmonary variables. The aging progress is associated with degenerative changes. These are associated with a decline in lung function. Literature considered age as a possible influential variable for pulmonary function. An inverse relationship between age and pulmonary function older than 30 years of age, have been reported.[9] Further, elastic recoil of the lung tissue reduces with increase in age. Residual volume increases but total lung capacity does not increase significantly.[10]

Population surveys using BMI have generally reported lower levels of ventilatory function among subjects with high BMI, and longitudinal analyses have found that BMI gain is associated with accelerated loss of ventilatory function. BMI was used as an index of relative adiposity. It is commonly reasoned that a substantial gain of adipose tissue should compromise pulmonary function, especially FVC, by compressing the chest wall and diaphragm.[11] Stepwise multiple regression has found that BMI and biceps skinfold thickness contributed significantly to prediction of residual volume and TLC.[12] Nevertheless, when subjects were divided into those with a waist (abdomen)- hip circumference ratio (WHR), VC and TLC were significantly less in those with larger WHR. We, in our study, used skin fold thickness as the measure of fat distribution and found a good predictive value of them for pulmonary function indices. Because increased WHR directly and biceps skinfold thickness indirectly are measures of upper body fat distribution,[13] we suggest that distribution of body fat (upper body vs lower body) has a significant effect on pulmonary function. Conversely, adipose tissue added solely to the lower body increases BMI but the fat is too distant to have any effect on lung volumes. Thus, an overall obesity index is not always a significant factor in determining lung volumes, but a fat distribution index may be; which can be assessed by measuring the skinfold thickness. Therefore, a potentially adverse effect on pulmonary function may be one or more consequence of upper body fat distribution.[11]

For formulating prediction equation of FVC, mid arm circumference also was found to be an important predictor which is positively correlated and in consistent with other study. Mid arm circumference and the biceps skin fold thickness, taken together, reveal fat and muscle relationships within the body.[13] As all the pulmonary measurements are effort dependent, hence, mid arm circumference played an important role in predicting the pulmonary indices.

Study from India and other western population have reported higher values of PEFR than those observed by us.[14] The physical features like height of their subjects were higher and incomparable in many ways to our figures. If this is substantiated, it would indicate that PEFR is more directly related to physical features than the other respiratory parameters. May be that is the reason why height stood as the only one predictor for predicting PEFR. Positive correlation of PEFR with height has been reported in adults and our results are consistent with those observation.[15]

Height, Supra iliac and mid arm circumference are found to be the predictor for formulating prediction equation of MVV. MVV is effort dependent; hence mid arm circumference played an important role in predicting the formulae. MVV depends on a number of physiological factors, including movement of the thoracic cage, the efficiency of respiratory muscles and lung resistance.[16] Therefore, MVV will decrease in person with airflow obstruction, respiratory muscle weakness, improper coordination and poor effort. Nowadays, the MVV test is most commonly performed as part of the exercise tolerance test.

From the present study, it is clear, therefore, that there cannot be a single universal equation that can be predictor for all groups. The use of normative data of pulmonary indices from a country as near as

India is also erroneous and can give a misleading picture. This has also been pointed out by Ann *et al*,[17] that there should be a population specific prediction equation.

We, for the first time, tried to evaluate the predictive value of skin fold thickness and mid arm circumference for different pulmonary variables. It was found that the upper body fat distribution, as reflected by biceps skin fold thickness and mid arm circumference, is a significant predictor of ventilatory function.

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Table-1: Pulmonary measurements of normal subjects

Parameters	**Mean ± SD**
FVC (l.)	3.027 ± 0.4823
FEV_1 (l.)	2.834 ± 0.4426
FEV_3 (l.)	3.027 ± 0.4823
PEFR (l./sec)	8.2606 ± 1.81
MVV (l./min.)	123.35 ± 23.90

Table-2: Physical and anthropometric measurements of normal subjects

Observations	**Mean ± S D**
Age (years)	27.13 ± 6.01
Height (cm)	164.84 ± 5.81
Weight (kg)	62.88 ± 8.85
Body Surface Area (m^2)	1.69 ± 0.12
Body Mass Index (kg/m^2)	23.13 ± 3.02
Mid arm circumference (cm)	25.31 ± 2.70
Biceps (mm)	2.26 ± 1.50
Triceps (mm)	5.02 ± 2.16
Supra iliac (mm)	7.21 ± 2.85
Abdominal girth (cm)	79.46 ± 9.06

Table-3: Correlation coefficients between physical and anthropometric variables with pulmonary variables

	Age	**Height**	**Weight**	**MAC**	**Biceps**	**Triceps**	**Supra iliac**	**AG**	**BSA**	**BMI**
FVC	-.458***	.542***	.049	.003	-.392***	-.296***	-.326***	-.095	.244***	-.241***
FEV_1	-.508***	.521***	.019	-.083	-.387***	-.311***	-.368***	-.175	.182*	-.302***
FEV_3	-.458***	.542***	.049	.003	-.392***	-.296***	-.326***	-.095	.244***	-.241***
PEFR	-.139*	.400***	.160*	.220**	.104	.057	-.014	.013	.272***	-.044
MVV	-.271***	.413***	.065	.086	-.167*	-.161*	-.225**	-.048	.213**	-.153*

$^{***}p \leq 0.001$, $^{**}p \leq 0.01$, $^{*}p \leq 0.05$
MAC = mid arm circumference, AG: abdominal girth,
BSA= body surface area, BMI= body mass index

Table-4: Regression analysis for predicting different pulmonary variables

	Mean	SD	Constant	REGRESSION COEFFICIIENTS					M. R.	S. E.
				Height	Age	Biceps	Mid arm circumference	Supra iliac		
FVC	3.027	.4823	-3.142	3.875	-.022	-.121	.026	-	.515	.3359
FEV_1	2.83	.4426	-2.145	3.534	-0.2	-.08	-	-	.509	.3102
FEV_3	3.027	.4823	-3.142	3.875	-.022	-.121	.026	-	.515	.3359
PEFR	8.26	1.812	-12.3	12.47	-	-	-	-	.154	1.66
MVV	123.35	23.90	-144.41	148.64	-	-	1.640	-2.602	.235	.219

S D: Standard Deviation M R: Multiple R, S E: Standard Error

Table-5: Prediction equations for lung function in males

FVC: 3.875Height – 0.022Age – 0.121Biceps + .026 Mid arm circumference – 3.1422

FEV_1: 3.534Height – 0.020Age – 0.08Biceps – 2.145

FEV_3: 3.875Height – 0.022Age– 0.121Biceps + .026 Mid arm circumference – 3.1422

PEFR: 12.47Height – 12.3

MVV: 148.64Height – 2.602Supra iliac + 1.64 Mid arm circumference – 144.41