Indian J Med Res 134, November 2011, pp 653-657

Pulmonary function studies in young healthy Malaysians of Kelantan, Malaysia

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Received May 20, 2010

***Background & objectives*: Pulmonary function tests have been evolved as clinical tools in diagnosis, management and follow up of respiratory diseases as it provides objective information about the status of an individual's respiratory system. The present study was aimed to evaluate pulmonary function among the male and female young Kelantanese Malaysians of Kota Bharu, Malaysia, and to compare the data with other populations.**

***Methods*: A total of 128 (64 males, 64 females) non-smoking healthy young subjects were randomly sampled for the study from the Kelantanese students' population of the University Sains Malaysia, Kota Bharu Campus, Kelantan, Malaysia. The study population (20-25 yr age group) had similar socio-economic background. Each subject filled up the ATS (1978) questionnaire to record their personal demographic data, health status and consent to participate in the study. Subjects with any history of pulmonary diseases were excluded from the study.**

***Results*: The pulmonary function measurements exhibited significantly higher values among males than the females. $FEV_{1\%}$ did not show any significant inter-group variation probably because the parameter expresses FEV_1 as a percentage of FVC. FVC and FEV_1 exhibited significant correlations with body height and body mass among males whereas in the females exhibited significant correlation with body mass, body weight and also with age. $FEV_{1\%}$ exhibited significant correlation with body height and body mass among males and with body height in females. $FEF_{25-75\%}$ did not show any significant correlation except with body height among females. However, PEFR exhibited significant positive correlation with all the physical parameters except with age among the females. On the basis of the existence of significant correlation between different physical parameters and pulmonary function variables, simple and multiple regression norms have been computed.**

***Interpretation & conclusions*: From the present investigation it can be concluded that Kelantanese Malaysian youths have normal range of pulmonary function in both the sexes and the computed regression norms may be used to predict the pulmonary function values in the studied population.**

Key words FEV_1 - $FEV_{1\%}$ - FVC - Malaysian - PEFR - pulmonary function

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Several reference values for spirometry have been published from different parts of the globe, such as pulmonary functions in Europeans[1,2], North American populations[3], populations from different parts of the Indian subcontinent[4-6], Chinese[7] and other non-Caucasian populations[8,9]. There are significant differences in pulmonary studies carried out in western world and Asian subcontinent due to significant differences in anthropometric parameters. There are also significant variations in respiratory pressures in different ethnic groups. Similar studies have been reported in Malaysian populations which comprises three main ethnic groups, namely Malays, Chinese and Indians[10]. However, these studies on Malaysian populations were conducted in the populations of Kuala Lumpur and Penang[10-13]. The normal standards for different dynamic pulmonary function measurements in Malaysian populations residing at other provinces (except Kuala Lumpur and Penang) of Malaysia have not yet been reported. Since habitat is one of the multifarious factors which influence lung function tests[14], the reporting of reliable reference standard for pulmonary function measurements from other provinces of Malaysia seemed important, especially in view of the paucity of pertinent data.

The present study was, therefore, aimed to determine the lung function parameters in normal young healthy non-smoking male and female Malaysian university students of Kelantan state (Kelantanese Malaysians), Malaysia; compare the lung function measurements with the previously reported data in Non-Kelantanese Malaysian populations as well as in populations from other countries; and derive reliable prediction formulae for lung volumes in the Kelantanese Malaysians.

Material & Methods

Selection of subjects: This cross-sectional study was conducted in the Sports and Exercise Science Laboratory of School of Health Sciences, University Sains Malaysia, Kelantan, Malaysia. A total of 128 (64 males and 64 females) non-smoking healthy young Kelantanese Malaysian subjects were randomly selected from the Kelantanese students' population of the University Sains Malaysia, Kota Bharu Campus, Kelantan. The study population belonged to the age group of 20-25 yr and with similar socio-economic background. The mean age, body height, body mass and body surface area (BSA) were 22.71±2.30 and 21.63±2.03 yr; 170.50±6.01 and 159.36±8.38 cm; 65.50±6.40 and 55.87±8.94 kg; 1.762±0.110 and 1.591±0.193 m^2 in male and female groups, respectively. The sample size was calculated using the method of Dupont & Plummer[15] where the input of confidence interval was set as 95%. The study was conducted with 64 subjects in each group which was greater than the computed sample size of 45 per group. Each subject filled up one questionnaire[16] to record their personal demographic data, health status and consent to participate in the study. Students doing regular exercise, having the history or existing obstructive or restrictive type of respiratory diseases and taking treatment for the same were excluded from the study. Subjects with any history of pulmonary diseases were also excluded from the study. The experimental protocol was explained to all the volunteers. Each subject signed the written informed consent form.

The study was approved by the Human Ethical Committee, University Sains Malaysia.

Preparation of subjects: Age of each subject was calculated in nearest year from the date of birth as obtained from the University record. Body height was measured with the subject standing barefoot on a stadiometer with an accuracy of ± 0.50 cm whereas the body mass was measured to an accuracy of ±0.1 kg by using a standard spring balance (Seca, Germany) with the subject wearing minimum clothing. Body surface area (BSA) was calculated using the equation of DuBois and DuBois[17].

Determination of dynamic pulmonary function measurements: The dynamic pulmonary functions were recorded on a computerised spirometer (Pony Spirometer Graphic 0476, Cosmed, Italy). The parameters measured were forced vital capacity (FVC), forced expiratory volume in 1 sec (FEV_1), FEV_1 as a percentage of FVC ($FEV_{1\%}$), mid expiratory flow rate ($FEF_{25-75\%}$), peak expiratory flow rate (PEFR) and forced expiratory time (FET). The spirometer was calibrated daily using calibration syringe of 2 liters. All the measurements were conducted in standing posture with nose clipped[18]. These tests were recorded at noon before lunch, as expiratory flow rates are highest at noon[19]. For each volunteer three satisfactory efforts were recorded with at least 3-5 min rest between the consecutive trials as per the standard norm[14]. The system was calibrated at source to read all measures at body temperature and pressure saturated with vapour (BTPS). In one subject, all the records *i.e.* anthropometric measurements and recording of pulmonary function measurements were conducted in one sitting on the same day.

Statistical analysis: Data were expressed as mean±SD. Student's t-test was used to compare the significance of difference between means. Pearson's product-moment correlation coefficient (r) was computed to test the significant relationship between two parameters. Regression analysis was done to compute the prediction norms for predicting pulmonary function measurements from different physical parameters. The level of significance was set at $P<0.05$.

Results & Discussion

The values of correlation coefficient between different physical parameters and the studied lung function parameters were shown in Table I. Depending on the existence of significant values of correlation coefficients, the simple and multiple regression norms for prediction of various pulmonary function measurements from different physical parameters were computed (Table II).

FVC and FEV_1 exhibited significant correlation with body height and body mass among males whereas in the female group FVC and FEV_1 exhibited significant correlation with body mass, body weight and also with age.

$FEV_{1\%}$ exhibited significant correlation with body height and body mass among males. $FEF_{25-75\%}$ did not show any significant correlation except with body height among females. However, PEFR which is considered as one of the most significant parameter to indicate one's pulmonary function status[6], exhibited significant positive correlation with all the physical parameters except with age among the females.

Since body height and body mass exhibited highest values of correlation coefficient with FVC, FEV_1 and PEFR in both the sexes, these two parameters were considered as the independent variables to compute the multiple regression norms for prediction of pulmonary function measurements in the studied population (Table III).

Comparison of pulmonary function measurements of the present study with those of foreign population and those of populations from other provinces in Malaysia is difficult due to variations in the anthropometric profiles that largely affect the lung function measurements. Due to such obstacle, the values of pulmonary function measurements reported in other studies were standardized with age and height for a valid comparison.

The values of FVC (3.94±0.63 and 2.75±0.45 l in males and females, respectively) and FEV_1 (3.55±0.55 and 2.49±0.41 l in males and females, respectively) in both the sexes were higher than the previously reported values among Malaysians[10,11]. However, the $FEV_{1\%}$ (90.13±4.19%) observed in the present study in male subjects was higher than that of the value reported from other provinces in Malaysia[10]. On the other hand, $FEV_{1\%}$ (90.86±4.49%) observed among females in the present study was lower than the earlier reported data from other parts of Malaysia[11]. Such difference might be attributed to the variation in habitat, ethnicity and the socio-demographic nature[14]. Singh *et al*[10] reported FVC, FEV_1 and $FEV_{1\%}$ values of 3.81±0.03 l, 3.43±0.03 l and 90.02±0.3 per cent in Malaysian males of Penang, Malaysia. The same group[11] reported FVC, FEV_1 and $FEV_{1\%}$ values of 2.60±0.02 l, 2.41±0.02 l and 92.4±0.4 per cent in Malaysian females from other privences of Malaysia. The $FEF_{25-75\%}$ and PEFR values observed in the present study were

Table I. Values of correlation coefficients between pulmonary function measurements and physical parameters in male and female young Kelantanese Malaysians of Kota Bharu

	Age (yr)		Body height (cm)		Body mass (kg)	
	M	F	M	F	M	F
FVC (l)	0.17	0.42*	0.82***	0.72***	0.76***	0.55**
FEV_1 (l)	0.17	0.36**	0.72***	0.71***	0.66***	0.57**
$FEV_{1\%}$ (%)	-0.10	-0.18	-0.40*	-0.04*	-0.38**	0.02
$FEF_{25-75\%}$ (l/min)	0.18	0.12	0.26	0.38**	0.21	0.37**
PEFR (l/min)	0.46***	0.27	0.66***	0.40**	0.78***	0.75***

M, male students, F, female students, $^*P<0.02$, $^{**}P<0.01$, $^{***}P<0.001$

FVC, forced vital capacity, FEV_1, forced expiratory volume in 1 sec; $FEV_{1\%}$, forced expiratory volume in 1 sec as percentage of FVC; $FEF_{25-75\%}$, mid expiratory flow rate; PEFR, peak expiratory flow rate

Table II. Simple regression norms for the prediction of pulmonary function measurements in male and female young Kelantanese Malaysians of Kota Bharu

Pulmonary function measurement	Sex	Regression equation	SEE
FVC (l)	Male	FVC = 0.086 H + 10.723	0.572
	Female	FVC = 0.036 H + 2.986	0.312
FEV_1 (l)	Male	FEV_1 = 0.066 H + 7.703	0.381
	Female	FEV_1 = 0.035 H + 3.0876	0.381
PEFR (l/min)	Male	PEFR = 8.302 H - 911.931	56.80
	Female	PEFR = 2.324 H - 8.283	44.63
FVC (l)	Male	FVC = 0.075 M - 0.9725	0.409
	Female	FVC = 0.0276 M - 1.208	0.376
FEV_1 (L)	Male	FEV_1 = 0.057 M - 0.1835	0.413
	Female	FEV_1 = 0.026 M - 1.0374	0.342
PEFR (1/min)	Male	PEFR = 9.214 M - 99.947	47.31
	Female	PEFR = 4.085 M - 133.84	32.21

H, body height; M, body mass; SEE, standard error of estimate. Abbreviations as given in Table I

266.83±59.8 and 204.34±54.8 l/min and 503.56±75.6 and 362.07±48.7 l/min in males and females, respectively.

The pulmonary function measurements depicted among males were higher than the male populations of South India[20], Nepal[21] and West Pakistani workers in UK[22]. The pulmonary function measurements of the males were comparable with the non-smoking men of Calcutta, India[5]. Values observed in the present study were also higher than the Rajasthan Indians[23].

The FVC observed among males in the present investigation was lower than the age-matched Europeans[1], New Guineans[24] and Senegalese[9]. The precise reason for these inter-ethnic differences is uncertain although it has been attributed to both genetic and environmental factors[14].

All the lung function parameters in females were lower in the present study in comparison with American, Jordanian, Caucasian and European populations[21,22,25]. The FVC and FEV_1 values obtained in Pakistani healthy adults[26] of similar age group were well comparable with the present study. Such finding might be attributed to the similarity in nutritional and socio-economic conditions of both the countries.

Majority of studies indicated significant positive correlation of body height with FVC, FEV_1 and PEFR as also observed in both the genders of the present investigation. Comparison of the present anthropometric data with previously reported data from Malaysia and other countries revealed that variation in FVC, FEV_1 and PEFR of the presently studied population differed proportionally with the body height of the concerned population.

In other studies[5,6,10,11], age exhibited significant negative correlation with pulmonary function measurements whereas in the present investigation females exhibited significant positive correlation. This finding might be due to younger age group and narrow age-range in the present investigation. Chatterjee *et al*[5] proposed that age related decline in pulmonary function measurements might be due to progressive loss of elastic recoil with aging even in absence of impairment by cigarette smoking and pulmonary diseases. Such age related changes might not have appeared in the present young population.

The FVC in females was higher than that of Indian women but lower than their European counterparts[25,27]. The age and height matched females of New Guineans[24] also had higher values of FVC than the females of the current study.

Table III. Multiple regression norms for the prediction of pulmonary function measurements in male and female young Kelantanese Malaysians of Kota Bharu

Pulmonary function measurement	Sex	Regression equation	R	R^2	SEE
FVC (l)	Male	FVC = 0.0646 H + 0.0238 M – 8.6332	0.83*	0.6897	0.35
	Female	FVC = 0.0384 H + 0.0003 M – 3.38616	0.72*	0.5183	0.31
FEV_1 (l)	Male	FEV_1 = 0.05148 H + 0.0161 M – 6.2818	0.73*	0.5287	0.37
	Female	FEV_1 = 0.0321 H + 0.0033 M – 2.8098	0.71*	0.5062	0.29
PEFR (1/min)	Male	PEFR = 0.2050 H + 9.0519 M – 124.2917	0.78*	0.5287	47.31
	Female	PEFR = -2.3362 H + 5.7513 M – 413.0417	0.79*	0.6315	29.58

*P<0.001; H, body height; M, body mass; SEE, standard error of estimate.
Abbreviations as given in Table I

Simple and multiple regression equations have been computed to use as norms for the prediction of FVC, FEV_1 and PEFR from body height and body mass in the studied population (Table III). The standard errors of estimate (SEE) of the computed equations are substantially small enough to recommend these norms for practical use in epidemiological studies and also in clinical settings.

From the present investigation it can be concluded that Malaysian youths have normal range of pulmonary function in both the sexes. However, the computed equations could be recommended as standard norms to predict the pulmonary function values in the studied population.

Acknowledgment

Author acknowledges Universti Sains Malaysia for financial support to conduct the study.

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