Med. J. Malaysia Vol. 47 No.4 December 1992

Spirometry and Flow-volume in Malay Adults

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Abstract

Respiratory function testing was done using a portable electronic spirometer in 223 normal Malay subjects between the ages of 15 to 75 years. Tests of FEV1, FVC, PEFR, and MMF were recorded using standard forced expiratory maneuvers. Malay adults have lower respiratory function values compared to Caucasians and other Asians.

Key words: Respiratory function, spirometry, Malay

Introduction

Respiratory function testing has become a routine part of the evaluation of patients with pulmonary disorders. The simplest test available for such evaluation is by spirometry[1,2] to measure the forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1). An assessment of airway obstruction is more easily appreciated if expiratory flow is plotted against exhaled volume[3,4]. Since unlike spirometry, this flow-volume plot is not effort dependent, it is helpful in detecting inadequate patient effort and it is also shown to be more reliable in detecting mild peripheral airway disease[2].

Ethnic differences in the normal range of spirometric values have been described[4,5-8]. There are many studies of normal function in adult Caucasians but only few reports have been published concerning Asians[4,5,9,10]. Studies in Singapore and Hong Kong included ethnic Chinese. To our knowledge, no data had been published regarding the respiratory function parameters in Malay adults.

The aim of this study is to define the range of normal values for spirometry and flow-volume parameters in normal Malay adults.

Materials and Methods

Two hundred and twenty-three normal subjects (94 males and 129 females) between the ages of 15 and 75 years were studied. The subjects consisted of hospital employees, medical students, doctors, nurses and relatives of patients at the Hospital Universiti Sains Malaysia, Kelantan. Smokers, ex-smokers and persons with symptoms of, or known to suffer from, cardiac or respiratory diseases were excluded.

Age was recorded to the nearest year; height was measured to the nearest centimetre with the subject barefoot; while weight (in light, street clothes) was recorded to the nearest half a kilogram. Spirometry and flow-volume curves were performed using the portable electronic spirometer (Microspiro HI-298, Chest Corporation, Japan) and standard techniques[11]. The forced expiratory maneuver was demonstrated to each subject following which the subjects performed the procedure while in the standing position. Subjects inspired to full total lung capacity, held breath and exhaled fully and forcefully without leaks and with the investigator giving encouragement at all times. Slow vital capacity maneuvers were also performed. Nose clips were used during the procedure. The best value from 3 acceptable attempts that met standard criteria of acceptability[11] was recorded in each subject.

The value of vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), maximum mid-expiratory flow rate (MMF) or MEF25-75, peak expiratory flow rate (PEFR) and the flow rates at 25%, 50% and 75% of the vital capacity (MEF25, MEF50, MEF75 respectively) were recorded.

The data were analysed separately for men and women. To test for the significance and the relative contributions of the relationship of each of the parameters the multiple regression and partial correlation coefficients were calculated. Multiple linear regressions were constructed for each measured parameter in relation to age and height.

Table I
Pulmonary function tests by age groups (mean±standard deviation)

Age (years)	Height (cm)	Weight (kg)	VC (l)	FVC (l/s)	FEV1 (l/s)	MMF (l/s)	PEFR (l/s)	MEF25 (l/s)	MEF50 (l/s)	MEF75 (l/s)
Male										
26.2 ±2.1 (n=61)	167.0 ±14.0	56.3 ±15.4	3.55 ±0.56	3.60 ±0.57	3.24 ±0.50	3.5 ±1.1	6.7 ±2.0	5.9 ±1.2	4.1 ±0.7	1.9 ±0.7
34.3 ±2.1 (n=19)	167.1 ±5.8	57.0 ±21.5	3.52 ±0.59	3.46 ±0.67	3.09 ±0.62	3.3 ±0.9	6.0 ±1.5	5.4 ±1.6	4.0 ±1.2	1.9 ±0.5
43.7 ±1.5 (n=7)	164.3 ±8.3	61.0 ±10.6	2.81 ±0.15	3.13 ±0.87	2.77 ±0.75	2.8 ±1.4	6.4 ±2.4	5.8 ±2.0	3.6 ±1.1	1.4 ±0.8
55.8 ±3.2 (n=6)	164.8 ±6.2	65.0 ±11.5	2.73 ±0.38	2.72 ±0.45	2.42 ±0.52	2.4 ±1.1	5.1 ±2.0	4.5 ±1.8	2.9 ±1.2	1.4 ±0.6
Female										
17.9 ±1.8 (n=8)	155.0 ±4.1	56.0 ±9.7	2.72 ±0.41	2.64 ±0.50	2.41 ±0.37	2.50 ±0.57	3.59 ±1.27	3.38 ±1.15	2.75 ±0.66	1.63 ±0.43
25.8 ±2.0 (n=72)	152.5 ±5.4	51.6 ±8.2	2.50 ±0.56	2.47 ±0.44	2.26 ±0.35	2.45 ±0.94	4.05 ±1.15	3.70 ±1.07	2.87 ±0.88	1.66 ±0.75
34.9 ±2.9 (n=37)	151.4 ±5.7	53.6 ±11.4	2.25 ±0.59	2.28 ±0.70	2.03 ±0.43	2.07 ±0.72	3.67 ±1.30	3.33 ±1.17	2.53 ±0.85	1.36 ±0.63
46.6 ±3.7 (n=7)	148.4 ±6.8	52.7 ±11.9	2.06 ±0.45	2.04 ±0.50	1.82 ±0.46	1.76 ±0.50	3.36 ±1.17	2.85 ±0.84	1.92 ±0.59	1.06 ±0.39
52.8 ±1.7 (n=4)	149.3 ±10.3	50.1 ±0.6	2.07 ±0.63	1.93 ±0.58	1.59 ±0.18	1.15 ±0.86	3.36 ±1.13	2.78 ±0.65	1.43 ±0.53	0.65 ±0.42
75.0 ±2.5 (n=1)	155.0 ±8.7	67.0 ±0.4	1.24 ±0.12	0.87 ±0.06	0.87 ±0.24	2.12 ±1.29	2.98 ±1.32	2.55 ±0.68	1.62 ±0.33	0.91 ±0.75

All volumes in BPTS

Results and Statistical Analysis

Table I presents the arithmetic mean and standard deviation (SD) of the physical characteristics and lung function data by age group. The correlation coefficient between physical data and the respiratory function measurement is shown in Table II. There were no significant differences in height or weight between different age groups amongst the men or women. In both sexes, the age correlated negatively with all respiratory function values.

Multiple correlations for each measured parameter in relation to age and height (Table III) indicate a significant correlation between the age and height of the subjects and the VC, FVC, FEV1 and MEF75. There was no significant correlation between body weight with any of the measured spirometric parameters.

Table II
Physical data and lung function measurements in male and female subjects: Correlation coefficient

	AGE	HT	WT	VC	FVC	FEVI	MMF	PEFR	MEF25	MEF50	MEF75
Male											
AGE	1.00										
HT	– 0.05	1.00									
WT	– 0.08	0.12	1.00								
VC	– 0.37	0.46	0.02	1.00							
FVC	– 0.40	0.24	– 0.00	0.83	1.00						
FEV1	– 0.43	0.23	0.05	0.73	0.90	1.00					
MMF	– 0.32	0.14	0.11	0.30	0.44	0.74	1.00				
PEFR	– 0.21	0.05	0.12	0.40	0.46	0.60	0.53	1.00			
MEF25	– 0.22	0.08	0.12	0.32	0.40	0.64	0.78	0.77	1.00		
MEF50	– 0.27	0.11	0.12	0.31	0.39	0.63	0.78	0.47	0.73	1.00	
MEF75	– 0.26	0.21	0.05	0.22	0.29	0.55	0.87	0.33	0.58	0.59	1.00
Female											
AGE	1.00										
HT	– 0.15	1.00									
WT	0.09	0.46	1.00								
VC	– 0.33	0.12	0.06	1.00							
FVC	– 0.36	0.22	0.09	0.53	1.00						
FEV1	– 0.49	0.23	0.08	0.51	0.77	1.00					
MMF	– 0.30	0.06	0.16	0.10	– 0.06	0.42	1.00				
PEFR	– 0.15	0.15	0.22	0.33	0.29	0.55	0.52	1.00			
MEF25	– 0.19	0.18	0.18	0.25	0.26	0.58	0.62	0.94	1.00		
MEF50	– 0.35	0.10	– 0.01	0.26	0.17	0.60	0.85	0.69	0.80	1.00	
MEF75	– 0.34	0.00	– 0.29	0.01	0.09	0.42	0.73	0.31	0.41	0.62	1.00

Table III
Multiple regression coefficient

		SEE	F	P
Male				
VC	–3.712 – 0.028 age + 0.026 ht	±0.575	22.60	< 0.05
FVC	2.416 – 0.029 age + 0.012 ht	±0.575	12.07	< 0.05
FEV1	2.283 – 0.028 age + 0.010 ht	+0.516	13.39	< 0.05
MMF	4.604 – 0.041 age	+1.030	0.72	< 0.05
PEFR	7.900 – 0.048 age	+1.929	4.29	< 0.05
MEF25	7.049 – 0.043 age	+1.639	4.86	< 0.05
MEF50	5.141 – 0.039 age	+1.203	7.13	< 0.05
MEF75	0.592 – 0.021 age + 0.011 ht	+0.668	5.40	< 0.05
Female				
VC	3.048 – 0.022 age	+0.549	15.5	< 0.05
FVC	0.486 – 0.021 age + 0.017 ht	+0.522	11.86	< 0.05
FEV1	0.895 – 0.022 age + 0.013 ht	+0.368	22.56	< 0.05
MMF	3.613 – 0.030 age	+0.843	12.48	< 0.05
PEFR	3.000 – 0.023 age + 0.030 wt	+1.171	5.23	< 0.05
MEF25	3.076 – 0.027 age + 0.023 wt	+1.072	5.19	< 0.05
MEF50	3.714 – 0.035 age	+0.839	17.22	< 0.05
MEF75	3.272 – 0.025 age – 0.019 wt	+0.645	13.80	< 0.05

Discussion

For most respiratory function measurements, sex is an independent predictor of normal values. This necessitates the use of different prediction equations for men and women. The basis for these differences is not well defined, but probably includes relative differences in thorax size and configuration[12], as well as differences in respiratory muscle strength.

Most respiratory function test results show a 'normal' decline as part of the normal aging process. For some tests (for example, residual volume, forced expiratory flow at 25% to 75 % of the forced vital capacity (FEF25-75), the changes attributed to aging in adults can be very substantial[13]. In our subjects, age correlated negatively with all the respiratory function measurements measured.

The values of the FVC, FEV1, PEFR, MEF75, MEF50 and MEF25 are all lower in our subjects when compared to the values found in other studies of respiratory functions done in Caucasian subjects (Tables IV and V). Comparisons of the predicted values of the lung function according to various authors show that Asian and African subjects have consistently lower values in all the measurements even after allowing for the effect of variation in age, height and weight[14,15,16]. The reason for these differences is unclear. Genetic and racial factors affecting body build, particularly thorax height and leg length, are suggested factors in Negroes, Smilie and Augustine[17] postulated that a smaller trunk:limb ratio would be a partial explanation. However, this has not been confirmed and similar studies in Asia have not been published. Except in populations in which nutrition is grossly inadequate, there is currently little direct evidence to support the possibility that nutrition or other socioeconomic factors are important determinants of predicted reference values for respiratory function tests[12].

We have defined the normal values for spirometric and flow-volume parameters in normal Malaysian subjects. We confirm that lung volumes in Asian men and women are smaller than in populations of European descent.

Table IV
Comparison of predicted spirometric values according to various workers

	Male Predicted values for height 1.67 m				**Female** Predicted values for height 1.50 m			
Study	25 years		50 years		25 years		50 years	
	FVC	FEV1	FVC	FEV1	FVC	FEV1	FVC	FEV1
Present (Malaysia)	3.34	3.20	2.59	2.45	2.99	1.90	2.49	1.40
Ayub et al (Pakistan:6)	3.97	3.36	3.82	3.06	2.30	2.15	1.98	1.73
ECC&S (European:18)	4.63	3.97	3.98	3.25	3.11	2.70	2.46	2.08
Knudson et al (American:10)	4.67	3.81	3.95	3.14	3.23	2.74	2.68	2.22
Lam et al (Chinese:4)	4.42	3.38	3.55	2.87	2.90	2.66	2.30	1.93

All volumes in litres, PTPS. Figures in parentheses refer to numbers in the reference section

Table V
Predicted values of maximum expiratory flow rates according to various workers

	Male (1.67 m height)							
	25 years				50 years			
	PEFR	MEF75	MEF50	MEF25	PEFR	MEF75	MEF50	MEF25
Present (Malaysian)	6.65	6.05	4.14	1.76	5.40	5.05	3.14	0.76
Ayub et al (Pakistan:6)	9.08	7.31	4.72	2.00	8.98	7.37	4.41	1.33
ECC&S (European:18)	9.33	7.92	5.20	2.37	8.25	7.20	4.43	1.72
Knudson et al (American:10)	8.83	8.20	5.75	2.91	7.95	7.33	5.37	2.61
	Female (1.50 m height)							
	25 years				50 years			
	PEFR	MEF75	MEF50	MEF25	PEFR	MEF75	MEF50	MEF25
Present (Malaysian)	4.51	4.20	3.23	1.62	3.64	3.50	2.43	0.68
Ayub et al (Pakistan:6)	4.00	3.95	3.00	1.38	3.53	3.35	1.97	0.86
ECC&S (European:18)	6.39	5.81	4.21	2.06	5.64	5.19	3.59	1.44
Knudson et al (American:10)	5.99	5.70	4.49	2.69	5.37	5.08	4.15	2.34

All volumes in litres, PTPS. Figures in parentheses refer to numbers in the reference section

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