ORIGINAL ARTICLE

Peak Expiratory Flow Rate in Elderly Malaysians

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Summary

An epidemiological survey was conducted among 1,414 healthy ambulatory elderly persons aged 55 years and above in the Kuala Langat district, Selangor. The relationship between peak expiratory flow rate (PEFR), demographic variables, socioeconomic status, smoking, alcohol use and respiratory symptoms were examined. The peak expiratory flow declined with age and were lower in women of all ages. Smoking had a modest effect on PEFR in men but not on PEFR in women. The combination of respiratory symptoms of cough, phlegm and wheeze were related to lower PEFR values. Prediction equations are presented derived from the population sample which may be of assistance in assessing observed to expected ratios among elderly people in Malaysia.

Key Words: Peak expiratory flow rate, Elderly, Malaysia.

Introduction

Lung function measured by spirometry strongly predicts total and cardiovascular mortality over 5 years in an elderly population[1], and may be a useful indicator of overall health in older people[2]. Peak expiratory flow rate (PEFR), though a relatively crude measure of lung function, has been found to correlate well with other measures of lung function [3]. PEFR has also been used as a screening tool in surveys as it can be measured on the field by non-medically trained persons with an inexpensive mini-Wright peak flow meter. The mini-Wright peak flow meter introduced in 1978 shows good correlation with the larger and more expensive Wright's peak flow meter[4]. Few studies have been done on PEFR in elderly populations in Asia[5,6,7]. There is a need for normal ranges of peak expiratory flow rates in the elderly for clinical use. This study was carried out to examine the relationship between PEFR and demographic factors, smoking, alcohol consumption, socio-economic status and symptoms of respiratory disease. Prediction equations of PEFR were derived from the sample of elderly population in the survey.

Methods

An epidemiological survey of the elderly in Kuala Langat district, Selangor was conducted over a six weeks period. The total population of Kuala Langat district, a semi-rural area was 126,519, with Malays, Chinese, Indians and other races comprising 50.1%, 27.3%, 18.5% and 4.1% respectively[8]. Subjects were selected by attendance at a free health screening service for elderly people provided as part of a public health campaign. Meetings with the five local community leaders and their respective village headmen were held to promote the planned health campaign. Health screening was conducted at specified sites such as government health centres located in each village or area, local community halls, or the estate clinics. The elderly population were recruited by obtaining a list of names drawn up by the respective village headmen. This was achieved by announcements made at religious meetings (usually held weekly), and house to house visits by local volunteers to identify those who were eligible. The health campaign was promoted via announcements in the local newspapers, newsletters, posters and banners placed at strategic points. Letters of invitation were posted to all those aged 55 years and above to attend the health survey centre nearest to their homes at a specified date. A follow up survey was also conducted to assess the health status of non-responders to the initial survey. This was organised in the 2 areas that had the lowest response rates in the initial survey.

The survey was conducted by trained staff supervised by the authors using a standardised questionnaire. The questionnaire included the demographic profile, educational background, health status (self-perception) and a history of smoking and alcohol intake. Past medical history and questions associated with respiratory symptoms like cough with phlegm, chronic cough, wheeze and shortness of breath were also noted. A modified version of the American Thoracic Society's ATC-DLD-78C respiratory questionnaire was used[9]. As part of other measurements of health of the subjects, PEFR readings were taken using a mini-Wright peak flow meter (Airmed,Clement Clarke Ltd.)[4] The mini-Wright peak flow meter was initially calibrated using a standard Wright's peak flow meter as a reference. Subjects were explained the purpose and the technique of the test in their own language followed by a demonstration of the technique. When the subjects understood the technique they were asked to take a deep inspiration and blow out as hard and as fast as they could into the instrument in a standing position. For those who were unable to stand, the measurement was taken in the sitting position. The maximum of the three efforts was used as a measure of PEFR. The standing height was measured without shoes in centimetres and the weight in kilogrammes. Height and weighing scales were calibrated daily. The data from the survey was analysed using SPSS package. Procedures such as cross-tabulation, ANOVA and multiple regression, were used.

Results

A total of 1,414 healthy ambulatory elderly subjects comprising of 70% Malays, 16% Chinese, 13% Indians and 1% other races were surveyed. The age of the subjects (n=1,414) ranged from 55-95 years, with a mean of 65 years. The distribution of age and height among the different ethnic groups is shown in Table I. The ANOVA procedure showed at least one of the ethnic groups was significantly different, (p=0.002) in terms of height. Further analysis with multiple comparison procedure showed that the Chinese were different in terms of mean height. The mean PEFR for the entire population was 323 (SD±120) l/min. Malays and Chinese had similar PEFR's (adjusted for height and age): 331l/min (SD±117), 317 l/min (SD±126) respectively. Indians had significantly lower PEFR:280 l/min (SD±117) {p value=0.00001}. PEFR declined with age in both men and women (Table II). Men who had ever smoked had significantly lower peak flows (p=0.00001) than non-smokers, who comprised 22.6% of the sample. There was no difference between the peak flow rates of the smoking and non-smoking women but the number of women smokers (6.9%) was small. Smoking had only a modest effect on the peak flow rates of men (p=0.04) and no effect on women (p=0.7) after adjustment for age and height (Table III).

Alcohol use had a strong effect in both men and women and was associated with about 40(SD±8)l/min. reduction in peak flow. Consumption of alcohol was more common among Indian subjects (42% versus 2.8% of the remainder) as shown in Table IV. However on adjustment for age and height (Table V) alcohol did not have a significant effect (p=0.698) on PEFR among the Indians.

All respiratory symptoms either alone or in combination were associated with lower peak flow values in both men and women (Table VI). Shortness of breath as a single symptom was also associated with much lower peak flow rates, suggesting that these subjects had significant airways obstruction.

The prediction of peak flow (Table VII) using a simple linear model without multiplicative terms explained more variation than the more complex models. In men,

Table I
Distribution ofAge and Height Among Different Ethnic Groups

Descriptives

	N	Mean	Std Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Age-IC								
Malay	995	65.50	8.13	.26	64.99	66.01	45	95
Chinese	229	64.30	6.94	.46	63.39	65.20	53	88
Indian	184	65.85	8.61	.63	64.60	67.11	55	95
Others	6	65.33	10.33	4.22	54.49	76.17	55	84
Total	**1414**	**65.35**	**8.03**	**.21**	**64.93**	**65.77**	**45**	**95**
height								
Malay	997	152.97	9.95	.32	152.35	153.59	110	184
Chinese	230	155.67	11.15	.74	154.22	157.12	110	184
Indian	184	152.32	9.77	.72	150.89	153.74	110	184
Others	6	152.83	15.42	2.21	147.15	158.52	146	159
Total	**1417**	**153.32**	**10.17**	**.27**	**152.79**	**153.85**	**110**	**184**

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Age-IC					
Between Groups	323.085	3	107.695	1.672	.171
Within Groups	90820.929	1410	64.412		
Total	**91144.014**	**1413**			
Height					
Between Groups	1578.372	3	526.124	5.135	.002
Within Groups	144769.594	1413	102.455		
Total	**146347.966**	**1416**			

Table II
Peak flow rate in relation to age, sex and smoking status. Figures in parentheses are number of subjects in each group (N).

	Age group				
Smoking Status	**55-**	**60-**	**65-**	**70-**	**75+**
Never smoked					
Men	418±114 (51)	394±134 (35)	419±116 (35)	341±125 (19)	279±121 (26)
Women	311±94 (188)	278±82 (135)	270±90 (80)	265±92 (55)	230±82 (52)
Ever smoked					
Men	400±120 (135)	372±112 (128)	359±139 (114)	305±119 (93)	295±113 (98)
Women	275±103 (40)	298±96 (25)	257±89 (24)	260±107 (25)	269±92 (11)

ANOVA F=59.5 for main effects of smoking and age, p<0.00001

Table III
Peak flow, smoking status and alcohol use
Age and height adjusted peak flow rates. Number of subjects in parenthesis (N).

Smoking	**Men**	**F-value**	**Women**	**F-value**
Never Smoked	379(166)	3.1	282(510)	0.36
Ex-smoker	348(166)	P=0.04	273(81)	P=0.7
Current Smoker	356(402)		279(44)	
Alcohol Use				
None	362(666)	5.2	282(598)	8.0
Drink Alcohol	328(68)	P=0.02	240(37)	P=0.005

only 20% of the variation in PEFR was explained by a model including age, height and education status and this fell to 12% in a model using just age and height.

In men who had never smoked and had no evidence of chronic chest disease the models which either include or exclude educational status showed similar proportions of

Table IV
Comparison of smoking and alcohol consumption among the ethnic groups

Ethnicity	Smoke	Currently Consuming Alcohol Yes	No	Total
Malay				
	Yes	4	398	402
	No	4	591	595
	Total	8	989	997
Chinese				
	Yes	8	52	60
	No	19	151	170
	Total	27	203	230
Indians				
	Yes	24	7	31
	No	53	100	153
	Total	77	107	184
Others				
	Yes		1	1
	No		5	5
	Total		6	6

Table V
Effect of Alcohol on PEFR (age and height adjusted) among Indians

Dependent Variable: PEFR

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	359848.929[a]	3	119949.643	10.085	.000
Intercept	2584.479	1	2584.479	.217	.642
Age	173401.298	1	173401.298	14.579	.000
Height	143024.599	1	143024.599	12.025	.001
Alcohol	1799.722	1	1799.722	.151	.698
Error	2033876.2	171	11894.013		
Total	15731150	175			
Corrected Total	2393725.2	174			

a. R Squared=.150 (Adjusted R Squared=.135)

Table VI
Peak flow rates (age and height adjusted) and symptoms of chest disease;number of subjects in parenthesis(N).

	Men	F-value	Women	F-value
Cough				
Yes	347 (330)	5.9	269 (237)	7.0
No	369 (440)	p=0.015	288 (398)	p=0.009
Phlegm				
Yes	343 (269)	7.8	266 (190)	7.5
No	369 (465)	p=0.005	287 (445)	P=0.006
Wheeze				
Yes	321 (111)	13.1	245 (58)	9.8
No	366 (623)	p<0.0001	284 (577)	P=0.002
Shortness of breath				
Yes	321 (204)	30.2	258 (159)	13.7
No	374 (530)	p<0.0001	289 (476)	P<0.000
Cough and phlegm				
Yes	343 (269)	7.8	266 (190)	7.5
No	369 (465)	p=0.005	287 (445)	P=0.006
Cough and phlegm daily				
Yes	306 (56)	12.0	218 (33)	17.1
No	364 (678)	p=0.001	284 (602)	P<0.0001
Cough, phlegm and wheeze				
Yes	296 (102)	34.5	244 (76)	14.3
No	370 (632)	p<0.000	286 (559)	P<0.0001

variation. Peak expiratory flow rate has been shown to be strongly associated with socioeconomic status, represented by education and income[10]. In women, a small proportion of variation in PEFR was explained by models including age, height and education. In women who had never smoked and had no symptoms the variation could be explained by the simpler model comprising age and height that was as good the as one which include the educational status. However the best model for the whole population should include sex, age, symptoms of cough, phlegm and wheeze, height and smoking.

Table VII
Prediction of peak flow rates

MEN
All subjects

PEFR = 273 + 1.98(height, cm) - 4.2 (age, yrs) + 27.7 (education@)
Multiple r2 = 0.20

PEFR = 330 + 2.1 (height, cm) - 4.5 (age, yrs)
Multiple r2 = 0.12

Never smoked, no symptoms of chest disease

PEFR = 186 + 2.26(height, cm) - 3.9 (age, yrs) + 52 (education)
Multiple r2 = 0.21

*PEFR = 275 + 2.7 (height, cm) - 4.8 (age)
Multiple r2 = 0.20

WOMEN
All subjects

PEFR = 346 + 0.6 (height, cm) - 2.7 (age, yrs) + 12.4 (education)
Multiple r2 = 0.06

PEFR = 355 + 0.7 (height, cm) - 2.8 (age, yrs)
Multiple r2 = 0.06

Never smoked, no symptoms of chest disease

PEFR = 390 + 0.5 (height, cm) - 3.1 (age, yrs) + 14.7 (education)
Multiple r2 = 0.08

#PEFR = 404 + 0.6 (height, cm) - 3.3 (age, yrs)
Multiple r2 = 0.08

TOTAL POPULATION
Best fit model:

PEFR = 345 - 80.4(sex) - 3.9(age,yrs) + 59.0(COPD) + 1.56(height,cm) -14(smoking).
Multiple r2 = 0.22

Notes
COPD present = 0, absent = 1; smoking never = 0, ever = 1
@Education was categorised as none = 1, primary level = 2, secondary = 3

Discussion

Most studies show that increasing age was associated with a steady decline in PEFR. The value is expectedly lower in women. The rate of decline of PEFR with increasing age in our population was similar to data reported in other studies[2,11]. Height is directly correlated to lung function and studies have shown that taller subjects have higher PEFR[12]. Smoking had only a modest effect on PEFR in men but no effect on PEFR in women. Previous analysis of the relation between smoking and the ventilatory function showed proportionately increasing deficits with the number of cigarettes smoked[13,14]. A probable explanation for the limited effects of smoking is that it was not possible to get accurate data on the number of cigarettes smoked and consequently data of a single group of current smokers was compared with a pool of non-smokers and ex-smokers. Furthermore, the method of smoking (non-inhalation) and type of tobacco smoked has been highlighted in earlier studies as possible explanations for the relatively harmless effects of smoking in some countries[15].

Alcohol consumption is known to accelerate deterioration of lung function over time[16], and often a parallel index of heavy smoking. Our initial findings showed that alcohol had a seemingly strong effect in lowering PEFR and Indians had a higher consumption of alcohol. However when adjusted for height and age (Table V) the effect on alcohol on PEFR among Indians was not significant ($p=0.698$).

Studies have shown that Indians have the lowest values of total lung capacity and vital capacity when compared to Chinese and caucasians[17]. The same workers found that caucasians and Chinese had longer chests than the Indians indicating that increased number of alveoli and larger chest cavities were explanation for the differences. The lower PEFR readings in Indians compared to the Chinese in our sample could probably be explained by the difference in heights, the Indians being shorter (Table I).

Respiratory symptoms especially cough, phlegm and wheeze were associated with a lower PEFR. Respiratory symptoms have been shown to have adverse health implications and are predictive of overall mortality[18].

Reference values for PEFR in elderly people have been reported[19,20] and allow an assessment of whether a low PEFR in an elderly person is more than expected and thus avoids attributing abnormal changes to age related declines. These prediction equations are routinely used in clinical practice in Western settings to provide "percent predicted" values for patients of different ages and heights. The prediction equations provided in (Table VII) may be used to obtain expected values based on age and height for men and women. For example, using the best fit equation, a man aged 70 years old with no symptoms of COPD, with a height of 170 cm (mean height of our population) and not smoking would have a predicted PEFR of:

$$\begin{aligned} \text{PEFR} &= 345-(80.4 \times 0)-(3.9\text{x}70)+(59.0\text{x}1)+ \\ &\quad (1.56\text{x}170)-(14 \times 0) \\ &= 396 \text{ l/min.} \end{aligned}$$

Using the simple equation of age and height for non-smokers:

$$\begin{aligned} \text{PEFR} &= 275 + (2.7 \times 170) - (4.8 \times 70) \\ &= 398 \text{ l/min.} \end{aligned}$$

The prediction derived from a British equation[19] is PEFR =542 l/min and an Indian equation[21] is PEFR =322 l/min. Our equation appears simpler than those using logarithmic transformations and gives estimates appropriate for South-East Asian populations. About 20% of variation in PEFR among men was explained in this data compared with Nunn and Gregg's study in which prediction equations of PEFR based on height and age explained about 30% of variation in PEFR[19]. Among women a much smaller amount of variation was explained and this may reflect difficulty with the technique leading to greater variation in the measurement of PEFR as voluntary effort has a considerable influence on PEFR and might have led to falsely low values[22]. Interestingly, investigators in India have reported up to 98% of variation explained in large samples of male non-smokers[21]. In our experience, finding large numbers of male non-smokers is extremely difficult and we would not expect such large amounts of variation to be explained in elderly subjects because of the increasing heterogeneity in biological variables associated with ageing. Differences in body build have been proposed as the probable explanation of variation of PEFR among Africans, Indians, Chinese compared to European subjects of corresponding of age and height[23]. That these differences are of racial rather than environmental in origin have been suggested by other studies[24,25,26]. The mixed ethnic origin of our subjects will have contributed to increased variability to our findings, thus reducing the amount of variation attributable to age and height alone.

The sample obtained appears to be comparable in terms of ethnicity and age structure with an earlier sample studied in Kuala Langat district as part of a WHO sponsored four countries study[27] and with local census data. Hence, the sample studied was broadly representative of elderly people in this area.

Under the circumstances it is unlikely a more representative sample would have been obtained by expending extra resources in carrying out a local census, mapping each household and inviting randomly selected individuals to attend.

Greater awareness of the need to assess older persons for reversibility is required[28,29]. In primary care where most cases of obstructive airway disease are managed, access to more sophisticated spirometry in developing countries is very limited and often peak flow meters are often all that is available. Measurement of peak expiratory flow rate may be easier than measurement of forced expiratory volume for older people[30]. A low or variable peak flow may alert the primary care physician to the possibility of an underlying obstructive airway disease with a reversible component. However, the greatest value of monitoring peak flow readings is in assessing the severity of disease and also the effects of therapy in patients with obstructive airway disease who are receiving inhaled bronchodilators and inhaled steroid therapy.

Peak expiratory flow is also a prognostic indicator in the older patient and a decrease in the peak expiratory flow rate is an important indicator of declining health in the elderly[1,2,30]. It reflects the strength and condition of respiratory muscles and the degree of airflow limitation in the large airways.

Residual PEFR adjusted for age, sex, height, weight and smoking is highly correlated with several measures of health in elderly including physical and cognitive function[31]. The prediction equations presented derived from local population samples may be of assistance in assessing the observed to expected normal values of PEFR among older people in Malaysia. The authors recommend the prediction equation (*) and (#) in Table VII for calculating the PEFR in men and women respectively, who are non-smokers and have no lung disease.

Conclusion

This study shows that among elderly Malaysians surveyed in Kuala Langat district lower PEFR was associated with increasing age, smoking, respiratory symptoms and the Indian ethnic group. Prediction equations for PEFR are presented for use by clinicians assessing elderly Malaysians. PEFR is a useful measure of lung function in elderly population and also serves as measure of overall health in them.

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