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PEAK EXPIRATORY FLOW RATE IN A RANDOM HEALTHY POPULATION OF COIMBATORE

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Abstract : Results of measurement of Peak Expiratory Flow Rate PEFR made on 1315 healthy persons ranging in age from 7-67 who attended a Medical Exhibition in the city of Coimbatore is analysed. Wide variation in parameters in Indian subjects observed, is attributed to regional variation in population and climate. Also, data collected on highly selected groups like students, sportsmen may not be truly representative of average population. Hence this study was conducted to obtain normal data of PEFR from healthy South Indians living in this region. A multiple regression equation has been developed. The relation of PEFR to age was found to be curvilinear with an increase to peak around the age group of 26-30 years in males and 21-25 years in females and then gradually declines.

Key words : PEFR mini peak flow meter age regression equations

INTRODUCTION

The measurement of PEFR is invaluable in the diagnosis and assessment of severity of airway obstruction. Several studies have been carried out to measure Peak Expiratiory Flow Rate (PEFR) to evaluate the influence of various factors such as age, sex, height, weight, environmental and ethnic differences on PEFR (1-5). The aim of these studies has also been to obtain data so that it can be used as reference. However, different studies have yielded different sets of regression equations as predictors of PEFR in the populations they have studied. The present study was conducted during the exhibition in Coimbatore Medical College in 1991, where measurement was done in a huge cross section of population which could not be covered otherwise.

METHODS

This study was conducted in the "Respiratory Function Analysis" section of the Physiology Department during the "Medical Exhibition" held in July 1991. A total number of 1,315 healthy people of whom 1,153 were males and 162 were females, in the age group from 7-67 were studied. From among those who attended, persons who gave history of wheezing and respiratory disease were excluded from the study. Healthy persons with no previous history

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of respiratory or other significant illness and recurrent or persistent cough and expectoration were selected for the study. Smokers have not been excluded, unless they admitted to chronic expectoration.

Measurement of PEFR:

It was carried out using the Mini Wright Peak Flow Meter manufactured by Airmed Clement Clarkes International Ltd. For all practical purposes, the Mini Wright Peak Flow Meter is identical with that of the standard instrument (6). Therefore the Mini Wright Peak Flow Meter was used. The technique was explained to every individual and this was followed by the demonstration of its performance. The subject was instructed to take a maximal inspiration and blow into the instrument rapidly and forcefully. Close watch was made to ensure that a tight seal was maintained between the lips and the mouth piece of the device. The value of PEFR achieved in 3 successive attempts at 2 min intervals was recorded. The 3 readings fell within 10% of each other and therefore the highest in 3 tests in the standing position was taken for analysis. A group of students were specially trained for this purpose.

The standing height was measured to the nearest centimeter and the weight recorded in kilograms.

Statistics

The data was treated in a computer in order to obtain the mean and SD values for PEFR and other physical and vital parameters for the various age groups. To derive regression equations for relationship of PEFR to height, weight and body surface area, constant and regression coefficients were obtained. The correlation coefficient and standard error of estimate (SEE) were also obtained. The results were considered significant if the P value was < 0.05.

RESULTS

PEFR was significantly higher in males than females in all age groups. Table Ia show that in males, PEFR is positively correlated with height, weight and body surface area. The correlation between age and PEFR is not significant by the linear equation. This is discussed subsequently. Table 1b shows that the finding in females is similar to that in males.

TABLE I(a) : Correlation of PEFR in L/min with physical characteristics in 1153 men.

	Mean	*S.D.*	*Correlation co-efficient with PEFR*	*Significance of correlation P*
Age (yrs)	26.7	10.8	0.021	N.S.
Height (cms)	165.5	8.9	0.363	0.01
Weight (kg)	55.9	11.8	0.278	0.01
Body surface area (sq.m)	1.6	0.2	0.348	0.01
PEFR (L/min)	372.0	75.4	—	—

TABLE I(b) : Correlation of PEFR in L/min with physical characteristics in 162 women.

	Mean	*S.D.*	*Correlation co-efficient with PEFR*	*Significance of correlation P*
Age (yrs)	18.8	8.5	0.171	0.05
Height (cms)	152.8	7.3	0.374	0.01
Weight (kg)	44.7	12.0	0.222	0.01
Body surface area (sq. m)	1.4	0.1	0.355	0.01
PEFR (L/min)	257.0	75.6	—	—

Regression equations were derived relating PEFR to height, PEFR to weight and PEFR to body surface area. The values of the constants, regression co-efficient and correlation co-efficient are shown in Table III.

The results of the findings related to height and age are tabulated in Table IIa for males and Table IIb for females. It can be seen in the extreme right column that PEFR increases with height both in males and females. The bottom row shows mean increases with age to a peak at 26-30 yrs for males and then declines with increasing age. For females, the peak occurs at the age group of 21-15 years. This is shown graphically in Figs. 1a and b.

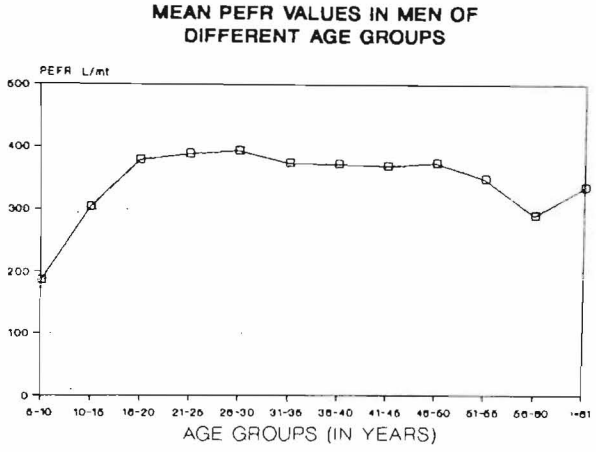

Fig. 1(a)

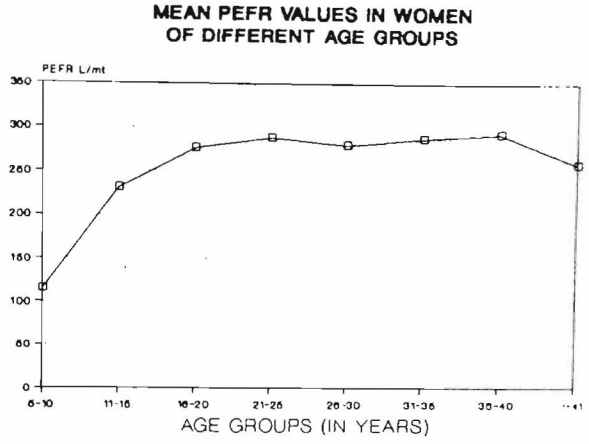

Fig. 1(b)

DISCUSSION

A positive correlation of PEFR with height has been reported in adolescents as well as in adults and our results are consistent with this observation.

The finding that correlation between PEFR and age is not significant is due to the nature of the PEFR changes with age which cannot be described by the linear equation we have devised. Fig. 1a and b shows that the graph is curvilinear with an increase of PEFR to peak around the age group of 26-30 yrs in males and 21-25 yrs in females. After the peak, PEFR values gradually decline with age. This has been pointed out by various authors who suggest that a non-linear multiple regression equation best describes the curvilinear graph plotting PEFR and age (2,7,8). The increase of PEFR with age has been reported in adolescents, in whom PEFR is positively correlated with age. Over 35-40 yrs PEFR is negatively correlated with age. A negative correlation for VC, MVV and FEF in healthy men and women over 40 years has been shown in Indian subjects (4). Its physiological significance may be that it reflects an increase in muscular power during adolescence seen as a consequent increase in PEFR with age in this age group. The subsequent decline in PEFR over the age of 40 years may reflect a gradual decline in muscular power in adults (4).

The significant finding, however, in our study is that the PEFR values are lower than those observed in other studies. Though care has been taken to exclude those with history of wheezing, however, undiagnosed eosinophillic lung and bronchial asthma cannot be excluded. They could range in percentage from 2%-7% (Deivanayangam, personal communication). It has also been pointed out that inclusion of large number of abnormal subjects with lower values might explain the differences (9). Moreover, because of the large standard error of PEF in both sexes, an observed value of PEF upto 100 l/mt below the predicted value should not be regarded as being necessarily abnormal (7). Table IV (a) and (b) shows a comparison of PEFR values between our study and that of Natarajan and Radha, for men and women. The latter was chosen for comparison, since the data for that study was obtained from a random population during an exhibition in Trichur, South India, similar to our study. There is a significant difference in PEFR values between the two studies in all age groups. Therefore, from the regression equation derived in our study, predictions will yield lower values of PEFR compared to other studies. There are several reasons for difference in predicted PEFR

TABLE II(a) : Mean values and standard deviations of PEFR in men of different age and height.

Ht. in cms	*Age in years*												*Mean for each ht.*
	5-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	>61	
103-107	–	–	–	–	–	–	–	–	360 (1)	–	–	–	360
108-112	200 (1)	–	–	–	–	–	–	–	–	–	–	–	200
113-117	–	–	–	–	–	–	–	–	–	–	–	–	–
118-122	–	–	–	–	–	–	420 (1)	–	–	–	–	–	420
123-127	165±25 (2)	–	–	–	–	–	–	–	–	–	–	–	165±25
128-132	200 (1)	–	–	–	–	–	–	–	–	–	–	–	200
133-137	–	214±24 (7)	–	–	–	–	–	–	–	–	–	–	214±24
138-142	200 (1)	236±64 (9)		350 (1)	–	–	–	–	–	–	–	–	262±64
143-147	–	249±54 (16)	287±70 (3)	–	270 (1)	–	–	–	–	280 (1)	–	–	210±62
148-152	–	284±70 (14)	307±53 (6)	333±25 (3)	330±20 (2)	360±10 (2)	317±46 (3)	350 (1)	–	–	–	–	329±29
153-157	– –	347±61 (14)	350±49 (15)	359±71 (9)	343±59 (16)	350±41 (4)	300±52 (4)	360±51 (4)	388±32 (3)	380±28 (3)	313±69 (3)	33 (1)	347±47
158-162	–	328±55 (16)	349±77 (33)	381±52 (44)	387±67 (32)	365±77 (17)	357±73 (19)	358±73 (11)	370±95 (11)	385±66 (6)	310±40 (2)	300±85 (3)	322±68
163-167	–	380±69 (13)	384±63 (73)	378±51 (69)	402±67 (53)	369±61 (32)	374±52 (18)	366±78 (20)	361±47 (12)	351±60 (8)	173±46 (3)	373±22 (3)	325±56
168-172	–	340±59 (3)	370±67 (73)	394±61 (88)	390±67 (49)	381±62 (24)	404±55 (13)	391±88 (17)	373±54 (3)	288±120 (5)	338±30 (4)	365±90 (4)	367±69
173-177	–	350±63 (6)	383±68 (58)	403±76 (52)	438±64 (18)	449±81 (8)	440±25 (7)	362±69 (8)	428±13 (2)	375±25 (2)	340 (1)	–	397±48
178-182	–	360 (1)	413±61 (16)	399±79 (14)	394±80 (8)	310±33 (3)	295±45 (2)	–	360 (1)	–	–	280±20 (2)	351±52
183-187	–	–	410±40 (2)	440±96 (5)	360 (1)	270 (1)	340 (1)	–	450 (1)	–	–	–	376±23
188-192	–	–	–	–	–	–	–	–	–	–	–	–	–
193-197	–	–	–	–	500 (1)	–	–	–	–	–	–	–	500
Mean for each age group	186±26 (5)	304±80 (99)	379±67 (279)	389±64 (285)	394±71 (180)	374±70 (91)	373±65 (68)	370±79 (61)	374±70 (34)	349±83 (25)	290±83 (13)	336±92 (13)	372±75 1153

TABLE II(b): Mean and standard deviations of PEFR in women of different ages and heights.

Height in cms	*Age in years*								*Mean for each each ht.*
	5-10	11-15	16-20	21-25	26-30	31-35	36-40	41 and above	
123-127	120 (1)	–	–	–	–	–	–	–	120
128-132	–	235±35 (2)	–	–	–	–	–	–	235±35
133-137	110 (1)	–	–	–	–	–	–	–	110
138-142	–	208±50 (4)	–	–	–	–	–	–	208±50
143-147	–	226±17 (18)	223±75 (6)	–	240 (1)	210 (1)	260 (1)	170 (1)	222±24
148-152	–	232±65 (15)	252±66 (13)	290±78 (3)	302±50 (4)	292±33 (4)	250±10 (2)	370 (1)	284±43
153-157	–	249±49 (16)	253±62 (23)	240±20 (2)	205±5 (2)	340 (1)	170 (1)	240±90 (2)	242±32
158-162	–	223±51 (9)	356±64 (9)	–	–	300 (1)	410±60 (2)	–	322±43
163-167	–	195±15 (2)	301±74 (7)	380 (1)	380 (1)	280 (1)	–	270 (1)	301±15
168-172	–	–	395±15 (2)	–	–	–	–	–	395±15
173-177	–	–	280 (1)	–	–	–	–	–	280
Mean PEFR for each age group	115±7 (2)	231±60 (66)	276±77 (61)	288±80 (6)	280±11 (8)	287±44 (8)	292±105 (6)	258±97 (5)	257±76 (162)

TABLE III : Regression analysis : For predicting PEFR from height, weight and body surface.

Predictors used	*Sex*	*Regression co-efficient of height (cms)*	*Regression co-efficient for weight (kg)*	*Regression co-efficient for body surface (sq.m)*	*Regression constant (a)*	*Correlation co-efficient (r)*	*SEE*
Height (cms)	M	3.1	–	–	–137.7	0.3637	70.28
	F	3.9	–	–	–336.4	0.3743	70.35
Weight (kg)	M	–	1.8	–	272.3	0.2790	72.45
	F	–	1.4	–	194.0	0.2225	73.97
Surface area (sq.mt)	M	–	–	141.8	143.4	0.3488	70.71
	F	–	–	181.6	7.6	0.3554	70.91
Height (cms) Weight (kg) and Surface area (sq.mt)	M	0.9	0.1	92.3	7.1	0.4433	67.84
	F	1.3	–6.8	622.5	–100.2	0.3900	70.14

TABLE IV(a) : Correlation of PEFR in healthy men from 2 medical college exhibitions in South India.

Age group (years)	*Present study 1991*	*Natarajan and Radha 1978*
16-20	375±69 (279)	498±52 (411)
21-25	389±64 (285)	518±61 (541)
26-30	394±71 (180)	515±55 (393)
31-35	374±70 (91)	409±54 (169)
36-40	373±65 (68)	491±54 (119)
41-45	370±79 (61)	492±56 (101)
46-50	374±70 (34)	484±54 (51)
51-55	349±83 (25)	468±50 (29)

n in paraenthesis

TABLE IV(b) : Comparison of PEFR in healthy women from 2 medical college exhibitions in South India.

Age group (years)	Present study 1991	Natarajan and Radha 1978
16-20	276±77 (61)	367±39 (71)
21-25	288±80 (6)	367±37 (53)
26-30	280±11 (8)	365±41 (30)
31-35	287±44 (8)	367±38 (22)
36-40	292±105 (6)	361±33 (17)
41 and above	258±97 (5)	342±35 (9)

n in paraenthesis

values obtained by different authors. These are the following :

a) Ethnic or racial differences have been well documented.

b) Differences in nutritional status within a population in the same race. Significantly Brooks and Waller (5) report that in their investigation in London, also conducted during an exhibition, the lower value PEFR compared to that reported by Gregg and Nunn was due to the lower socio-economic background of his group.

c) Environmental exposure differences within a population such as difference in exposure to air pollution leads to lower PEFR values in factory workers. Coimbatore is an industrial town with significant air pollution.

d) In addition, the degree of physical activity of the population affect values of ventilatory function (12).

e) Differences in technique or instruction given to subjects, small departures from the correct technique of performing the test may cause spuriously low values of PEF. Because of the dependence of PEFR on the muscular effort exerted in a forced expiration, where the maximum effort is important (10).

f) We have not excluded smokers in the series unless they admitted to chronic expectoration or gave history of previous chest disease. The number of smokers included in this study are 270, mean age of 29.86±9.75 range 17-67 and mean height 167.18±6.7, range 150-194, PEFR mean 374.4±68.17 range 170-580. For the 883 non-smokers, the mean age is 25.7±10.9 range 7-66 yrs, height 165±9.4 range 104-185 PEFR 371.23±77 range 110-650.

However, it is unlikely that the regional difference can be explained solely due to inclusion of smokers, especially considering the wide range of age of large number of subjects tested in this study. Infact, the values appear to be very similar for the two groups.

g) Geographic differences could be a factor.

CONCLUSION

From our study, it is clear therefore that there cannot be a single universal regression equation that can be a predictor for all groups. It is imperative to realize this, especially because there is a tendency, while using commercial Computerised Spirometers, to compare the

observed values in the study with predicted values of probably a different population.

Wide variation in parameters in Indian subjects observed is attributed to regional variation in population and climate, also data collected on highly selected groups like students and sportsmen. Industrial workers may not be truly representative of average population (11).

From the present study, we recommend, therefore, for any evaluative study, it is necessary not only to use age, sex, height, weight and ethnically matched controls, but also matched with respect to other variables, rather than compare with predicted values which are derived from regression equations obtained in a different population. It may be useful for a laboratory to establish its own norms for comparison, which may be made by using the appropriate statistical analysis either parametric or non-parametric. This has also been pointed out in a study as early as 1972 on factors affecting normal values for ventilatory lung function by Woolcock et al., who suggested for accurate prediction, formulae for measurement should be derived from individual population (9).

There is a need for establishing regression equations to predict instantaneous flow rates on a regional basis for a comparitive study in a sub-continent like India. A multiple regression equation has been developed for prediction of PEFR in the present study on healthy average population of Coimbatore city, where measurement was done in a huge cross - section of population which could not be covered otherwise.

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