

Pulmonary Function in Asymptomatic Asthmatic Children

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Summary

Aderele WI and Oduwole O. Pulmonary Function in Asymptomatic Asthmatic Children. *Nigerian Journal of Paediatrics* 1983; 10: 73. Peak flow rate (PFR) was determined in 145 and forced expiratory volume in the first second (FEV_{1.0}) in 71 asthmatic children who were clinically well. These two indices of pulmonary function were also determined in an equal number of controls. The values obtained for both asthmatics and controls compared with predicted mean values, using height as the measured variable, showed that 97% and 98.6% respectively, of the controls had PFR and FEV_{1.0} values above the predicted mean values minus 2 standard deviations, as against 58% and 44% respectively, of asthmatics ($p < 0.001$; $p < 0.001$, respectively). The mean PFR and FEV_{1.0} values of 228.0 litres/min and 1.51 litres/min respectively for the controls, were higher than 158.9 litres/min and 1.04 litres/min respectively, for the asthmatics ($p < 0.001$). There was however, no significant difference between the values obtained and the severity of asthma. It is concluded that a good proportion of asthmatic children have poor pulmonary function during remission and this poor function cannot be detected clinically. In order to detect those who may have residual bronchial obstruction even when they are in clinical remission, we recommend that pulmonary function should be performed routinely in all asthmatic children during clinic follow-ups.

Introduction

VARIOUS aspects of asthma among Nigerian children including clinical, laboratory, socio-economic factors and skin reactions have recently been reported.¹⁻⁴ However, there has been no information on the pulmonary function in these children, although it is important to have this

information since it is known that these tests are useful, not only in the diagnosis but also in the subsequent management of respiratory problems in general and bronchial asthma in particular.⁵

The purpose of the present study was to determine the peak flow rate (PFR) and the forced expiratory volume in the first second (FEV_{1.0}) in asthmatic children during symptom-free periods and to compare the values so obtained with predicted mean values as well as with those obtained in controls. It was also hoped to evaluate the usefulness of these tests in the assessment of the severity of the disease.

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Materials and Methods

The subjects were asthmatic children attending the Asthma and Chest Clinics, Department of Paediatrics, University College Hospital (UCH), Ibadan. Diagnosis of asthma was based on a history of at least, three distinct episodes of cough, breathlessness and wheezing, which in many cases, had responded to bronchodilators. Confirmation of the diagnosis during subsequent attendance at the follow-up clinic, was based on the following criteria:

- (a) auscultatory findings of widespread expiratory rhonchi which responded to bronchodilator therapy;
- (b) a minimum of 20% increase in the respiratory peak flow rate as measured by Wright's peak flow meter, after the administration of a bronchodilator in those who subsequently presented in acute attacks and
- (c) demonstration of bronchial lability by exercise test.

The severity of the disease was based on the frequency of attacks and was graded as mild, moderate and severe.¹ After clinical examination and measurement of height as previously described,⁴ the PFR and FEV_{1.0} were determined, using Wright's peak flow meter and the Vitalograph wedge spirometer, respectively.^{6,7} Each ventilatory index was determined three times in each child and the best of the readings was recorded as the PFR or FEV_{1.0}. Well children and those with normal respiratory signs on physical examination, were included in the study. Similar tests were carried out on an equal number of apparently healthy children (controls) matched for sex, height and as much as possible, age. The values obtained were plotted against predicted values.^{6,7} Statistical analysis was undertaken, using the chi-square (X^2) and Student's 't' tests.

Results

Peak flow rate

The peak flow rate (PFR) was determined in 145 asthmatic children and the same number of

controls. They consisted of 86 males and 59 females aged between 3 and 13 years. The heights of the children ranged between 100cm and 159cm. Of the 145 asthmatics, the disease was mild in 63 (43%) moderate in 37 (26%) and severe in 45 (31%).

Figs 1 and 2 compare the PFR values at different heights of the asthmatics and controls with the predicted mean (PM) values and the predicted mean values minus 2 standard deviations (PM-2SD), in males and females, respectively. The height was used as the measured variable because it has been shown to correlate best with PFR.⁶ Table I summarizes the PFR values in the subjects as well as in the controls compared with the predicted mean values. It will be observed from the Figs and Table I that of the 145 asthmatics, the PFR was above predicted mean in only 8 (6%). Seventy-six (52%) others had values which were between PM and PM-2SD, while the remaining 61 (42%) had values less than PM-2SD. In contrast, values above the PM were obtained in 77 (53%) and values below PM-2SD in 4 (3%) of the controls. These differences were highly significant ($p < 0.001$). When the mean values of the PFR in asthmatics and controls were compared (Table II), the mean of 158.9 litres/min for the asthmatics was significantly lower than 228.0 litres/min for the controls ($p < 0.001$). The mean value for the asthmatics was 69.7% of that for the controls.

PFR and severity of asthma

The PFR according to the severity of asthma compared with the PM (Table III) shows that the values were above the predicted mean value in 4 (6%) of 63 mild asthmatics, one (3%) of 37 moderate cases and in 3 (7%) of the 45 severe cases. The corresponding numbers for those with PFR below PM-2SD were 25 (40%), 12 (32%) and 24 (53%), respectively. These differences were not significant ($p > 0.1$).

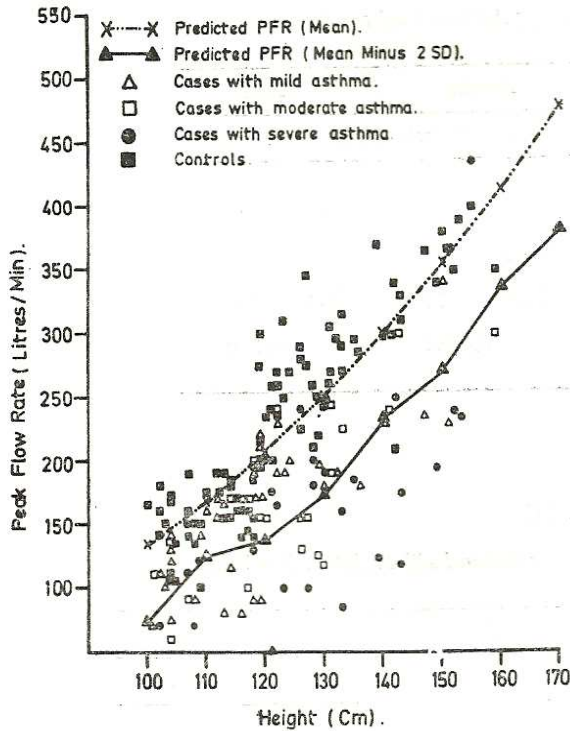


Fig. 1 PFR values in 86 male asthmatics and 86 male controls plotted against
 (a) predicted mean values and
 (b) predicted mean values minus 2 standard deviations

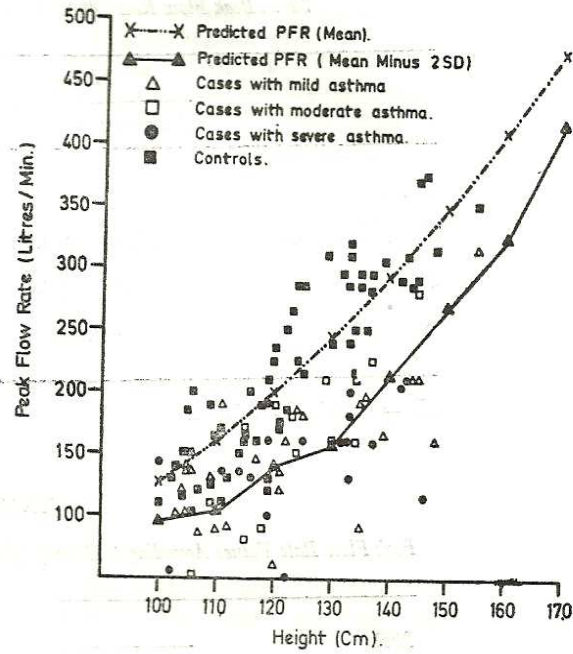


Fig. 2 PFR values in 59 female asthmatics and 59 female controls plotted against
 (a) predicted mean values and
 (b) predicted mean values minus 2 standard deviations

TABLE I

Peak Flow Rate (PFR) Values in 145 Asthmatics and 145 Controls compared with Predicted Mean Values

PFR	Asthmatics				Controls			
	No. of Cases				No. of Cases			
	Males	Females	Total	% of Total	Males	Females	Total	% of Total
Above PM	6	2	8	6	48	29	77	53
Between PM and PM minus 2SD	44	32	76	52	36	28	64	44
Below PM minus 2SD	36	25	61	42	2	2	4	3
Total	86	59	145	100	86	59	145	100

PM = Predicted Mean
 SD = Standard Deviation
 $\chi^2 = 107.0250$ on 4df; $p < 0.001$

TABLE II

Mean Peak Flow Rate (PFR) Values in 145 Asthmatics and 145 Controls

	Males		Females		Total	
	Asthmatics	Controls	Asthmatics	Controls	Asthmatics	Controls
No. of Cases	86	86	59	59	145	145
Mean PFR (Litres/min)	164.9	232.8	150.3	221.1	158.9	228.0
SD	65.7	78.4	53.3	74.4	61.2	76.7
P	<0.001		<0.001		<0.001	

SD = Standard Deviation

TABLE III

Peak Flow Rate Values According to Severity of Asthma compared with Predicted Mean Values

PFR	Mild			Moderate			Severe		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
Above PM	3	1	4	1	0	1	2	1	3
Between PM and PM minus 2SD	20	14	34	14	10	24	10	8	18
Below PM minus 2SD	14	11	25	8	4	12	14	10	24
Total	37	26	63	23	14	37	26	19	45

PM = Predicted Mean
SD = Standard Deviation $X^2 = 5.1838$ on 4df; $p > 0.1$ *FEV_{1.0}*

FEV_{1.0} was determined in 71 cases (37 males and 34 females), aged between 6 and 13 years. The heights ranged from 112cm to 159 cm. Twenty-nine (41%) of the 71 asthmatics were mild cases, 16 (22%) were moderate, while the remaining 26 (27%) were severe cases. Only one (1.4%) of the 71 asthmatics had FEV_{1.0} value above the predicted mean value (Figs. 3 & 4; Table IV). Thirty (42.3%) had values between PM and PM-2SD, while in the remaining 40

(56.3%) cases, the FEV_{1.0} was below PM-2SD. By contrast, 30 (42.3%) of the 71 controls had FEV_{1.0} above the PM value, 40 (56.3%) had values between the PM and PM-2SD, while only one (1.4%) had FEV_{1.0} below PM-2SD. These differences were highly significant ($p < 0.001$). A comparison of the means between asthmatics and controls (Table V) showed that the asthmatics had a mean FEV_{1.0} of 1.04 litres which was significantly lower than 1.5 litres for the controls ($p < 0.001$). The mean value for the asthmatics was 68.9% of the mean for the controls.

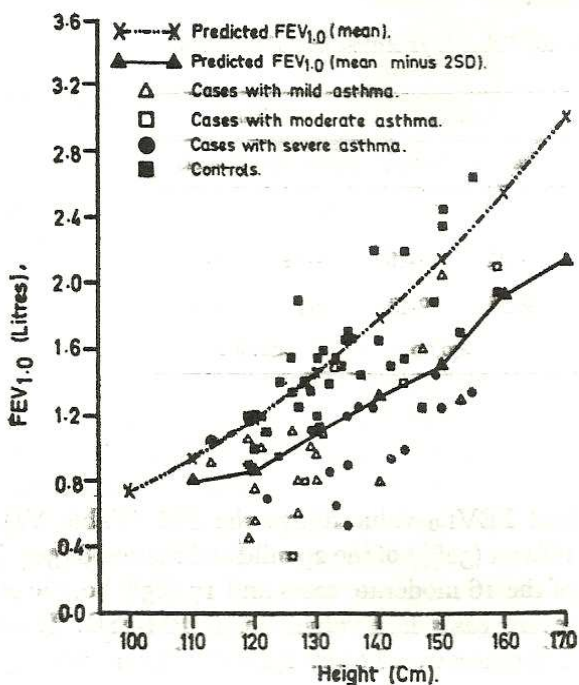


Fig. 3 $FEV_{1.0}$ values in 37 male asthmatics and 37 controls plotted against
 (a) predicted mean values and
 (b) predicted mean values minus 2 standard deviations

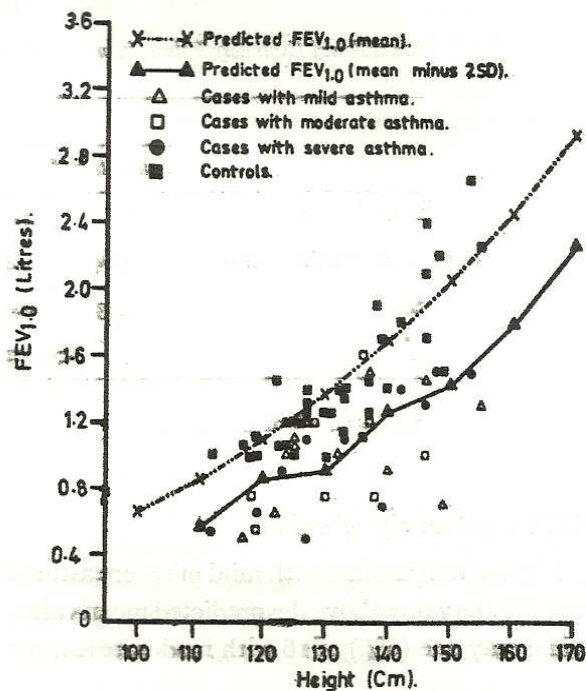


Fig. 4 $FEV_{1.0}$ values in 34 female asthmatics and 34 female controls plotted against
 (a) predicted mean values and
 (b) predicted mean values minus 2 standard deviations

TABLE IV

Forced Expiratory Volume in one second ($FEV_{1.0}$) Values in 71 Asthmatics and 71 Controls compared with Predicted Mean Values

PFR	Asthmatics				Controls			
	No. of Cases				No. of Cases			
	Males	Females	Total	% of Total	Males	Females	Total	% of Total
Above PM	0	1	1	1.4	16	14	30	42.3
Between PM and PM minus 2SD	13	17	30	42.3	20	20	40	56.3
Below PM minus 2SD	24	16	40	56.3	1	0	1	1.4
Total	37	34	71	100.0	37	34	71	100.0

PM = Predicted Mean
 SD = Standard Deviation

$\chi^2 = 165.6552$ on 4df; $p < 0.001$

TABLE V

Mean Forced Expiratory Volume in one second (FEV_{1.0}) Values in 71 Asthmatics and 71 Controls

	Males		Females		Total	
	Asthmatics	Controls	Asthmatics	Controls	Asthmatics	Controls
No. of Cases	37	37	34	34	71	71
Mean FEV _{1.0} (litres)	1.04	1.56	1.04	1.45	1.04	1.51
SD	0.43	0.41	0.38	0.43	0.4	0.43
p	<0.001		<0.001		<0.001	

SD = Standard Deviation

FEV_{1.0} and severity of asthma

None of the patients with mild or severe asthma had FEV_{1.0} value above the predicted mean value, while only one (6%) of 16 with moderate asthma

had FEV_{1.0} value above the PM (Table VI). Fifteen (52%) of the 29 mild asthmatics, 8 (50%) of the 16 moderate cases and 17 (65%) of the 26 severe cases had values below PM-2SD. These differences were however, not significant ($p > 0.1$).

TABLE VI

Forced Expiratory Volume in one Second (FEV_{1.0}) Values according to Severity of Asthma compared with Predicted Mean Values

FEV _{1.0}	Mild			Moderate			Severe		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Above PM	0	0	0	0	1	1	0	0	0
Between PM and PM minus 2SD	6	8	14	4	3	7	3	6	9
Below PM minus 2SD	10	5	15	3	5	8	11	6	17
Total	16	13	29	7	9	16	14	12	26

PM = Predicted Mean
SD = Standard Deviation

$X^2 = 5.1838$ on 4df; $p > 0.1$

Discussion

In the present study, the PFR and FEV_{1.0} were pulmonary function indices evaluated because they were relatively easy to perform and the necessary equipment were available. In addition, the same equipment were used previously

by us, to establish normal and predicted values for these indices among apparently healthy school children.^{6, 7} Symptom-free asthmatic children were chosen for the study because it was expected that such children during acute attacks and others with respiratory signs of bronchial obstruction in the interphase between attacks, would, as has been shown by others,^{8, 9} have abnormally, low PFR and FEV_{1.0} values.

The mean value of either index in asthmatic children, most of whom were on intermittent bronchodilator therapy, was significantly lower than that in the controls. Furthermore, a significant proportion of the asthmatics (42% with respect to PFR; 56.3% for FEV_{1.0}) had values less than 2 standard deviations below the predicted mean. Such values are usually regarded as being abnormal and indicative of a significant degree of bronchial obstruction.⁵ This finding is in contrast to those by Weng and Levison⁹ who reported that there were no significant differences in PFR and FEV_{1.0} values between normal children and asthmatics at symptom-free status, although such differences were evident when the maximal mid-expiratory flow rates were compared. The observed differences between our findings and those of Weng and Levison⁹ may be due partly, to a possible higher rate of bronchodilator therapy in their subjects compared to ours.

In addition to establishing PFR and FEV_{1.0} values in symptom-free asthmatic children, the present study has revealed that an asthmatic child who has apparently normal lungs on auscultation, may have some degree of bronchial obstruction as evident in the series. Persistence of any degree of obstruction even during asymptomatic periods may predispose to the development of chronic hyperinflation of the alveoli. Thus, in order to identify those asthmatic children who are at risk of developing such complications as a result of persistent residual bronchial obstruction during apparent remission, pulmonary function tests should be undertaken. It is therefore, suggested that one or both of these indices should be determined routinely in asthmatic children during follow-ups at the clinic. Such determinations would indicate the need for appropriate therapy even in those with apparently clear lungs; it would also provide a guide as to the frequency of follow-up. It is easier and less time-consuming to determine the PFR than FEV_{1.0}; the equipment for its measurement is cheaper and its use is independent of an electricity supply unlike the Vitalograph required for measuring the FEV_{1.0}.

Therefore, PFR should perhaps, be the one to be determined routinely, if and when a choice has to be made.

There was no significant relationship between the severity of asthma and the values of the pulmonary function indices. It is, however, worthy to note that PFR and FEV_{1.0} values below the predicted mean minus 2 standard deviations were obtained in a higher proportion of severe cases than those with mild or moderate disease. Thus, an occasional determination of the PFR and FEV_{1.0} in symptom-free asthmatic children is perhaps, not as reliable as might be expected in grading the severity of the disease. Children with severe asthma would however, be expected to have a significantly worse pulmonary function than those with mild or moderate disease presuming that severe asthmatics who are subjected to more frequent attacks would be more likely to have bronchial obstruction in between attacks than those with mild disease. That this was not the case as evident from the present study might have been due to the fact that the extent to which the bronchi recover patency in between attacks has no direct relationship to the frequency of acute attacks which was the criterion we used to grade the disease.

Acknowledgement

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