PEAK EXPIRATORY FLOW RATE IN SOUTH INDIAN CHILDREN

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ABSTRACT

PEFR is a simple and reliable way of following patients with bronchial asthma and other obstructive airway diseases. Normal data is available for Caucasian and North Indian children but not for ethnic South Indian children. We, therefore, measured Peak Expiratory Flow Rate (PEFR) in 345 healthy South Indian children aged 4-15 years, using the Wright mini peak flow meter. A nomogram was constructed relating PEFR to height. Prediction equations for PEFR using height alone or height, age and weight were determined for both sexes. The prediction equation for boys based on height alone was PEFR = 4.08 height (cm)–284.55 and for girls was PEFR = 3.92 height (cm)–277.01.

Key words: *Peak expiratory flow rate, South Indian Children, Bronchial Asthma.*

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The peak expiratory flow rate (PEFR) measurement is a simple and reliable way of judging the degree of airway obstruction in various obstructive lung diseases, especially asthma. It is easily measured using a peak flow meter and can be recorded even by the patient or his parents at home. Bronchial asthma, one of the common respiratory ailments of childhood, is associated with frequent fluctuations in airway calibre and one of the earliest signs of an impending acute attack is a fall in the PERT. Also, the response to treatment can be monitored using serial PEFR measurements(1,2).

Nomograms predicting PEFR from height are available for Western children(3-7). Such information is available for North Indian(8,9) and South Indian adults(10,11) and North Indian children living at sea level(12,13) and highlands(14) but no data is available for South Indian children. From studies in adults, we know that lung volumes are smaller in South Indians as compared to North Indians and therefore it is important to have regional reference values. The objective of our study was to obtain PEFR values for healthy South Indian children. We performed PEFR measurements on a group of 345 children aged 4-15 years, living in the Madras area. The data can be used as reference values for this population.

Material and Methods

Three hundred and forty five children from a group of 1400 school children at tending a Health Camp organised by the Tamilnad Hospital, Madras were randomly selected for this study. Children with a history of asthma or other chronic respiratory disorders were excluded. The mean age of the subjects was 8.73 ± 2.85 (SD) years with a range of 4-15 years. There were 191 girls and 154 boys. The children came from a mixed background though most of them were from a lower socioeconomic group. All the children were examined thoroughly to exclude any underlying heart, lung or systemic disease. Standing height and weight were recorded.

A Mini Wright peak flow meter (Clement Clarke International Ltd, U.K.) was used to measure PEFR. All children were first tested using the low range pediatric peak flow meter (range 0–350 L/min) and if the PEFR exceeded the upper limit they were then tested on the standard (adult) flow meter (range 60–800 L/min).

All the children were tested in the standing position. The manoeuvre was explained and demonstrated to them. Each child was told to take a deep breath and then blow into the peak flow meter as hard and fast as he or she could. Each child was given 2 trial runs and encouraged to blow harder each time. The child then blew into the Wright peak flow meter 3 times and the highest reading was accepted in each case.

Statistical analysis was done using the SPSS package in an IBM/XT computer. Linear and multiple regression analysis was performed using age, weight and height as the independent variables and PEFR as the dependent variable. A nomogram relating PEFR to height was constructed using the data.

Results

The data was analyzed separately for boys and girls. The mean age of the boys was 8.9 ± 2.3 years, mean height was 121.4 ± 4.5 cm (range 92-161 cm) and mean weight was 21.5 ± 14.5 kg (range 12-4[illegible] kg). The mean age of the girls was 9.12 ± 2.94 years, mean height was 123.5 ± 14.4 cm (range 92-154) and mean weight was 22.7 ± 7.57 kg (range 11-48 kg). PEFR measured ranged from 60 to 440 L/min. Table I gives the PEFR values for each age group. PEFR increased progressively with age and showed a very good correlation with height, age and weight in both sexes. The highest correlation was obtained between PEFR and height ($r = 0.84$, $p<0.001$) but correlations with age ($r = 0.79$, $p<0.001$) and weight ($r = 0.81$, $p<0.001$) were also highly significant. The prediction equations for PEFR based on height alone (1) and height, age and weight(2) are given below, for boys and girls separately:

TABLE I—*Distribution of PEFR in Different Age Groups*

Age (years)	Male			Female		
	Mean (L/min)	SD	N	Mean (L/min)	SD	N
4 – 5	150	28.5	34	130	26.0	25
6 – 7	173	29.9	30	156	33.8	25
8 – 9	201	37.6	49	197	42.4	[illegible]
10 – 11	239	45.0	22	222	44.1	[illegible]
12 – 13	290	48.2	9	272	[illegible]	[illegible]
14 – 15	333	59.8	10	309	[illegible]	[illegible]
Mean	203	63.0	154	210	65.4	[illegible]

(i) PEFR = 3.92 height (cm) – 277.01 (Female)
PEFR = 4.08 height (cm) – 284.55 (Male)

(ii) PEFR = 2.03 height (cm) + 3.18 age (years) + 2.71 weight (kg) – 132.92 (Female)

PEFR = 2.04 height (cm) + 4.78 age (years) + 2.73 weight (kg) – 134.29 (Male).

It was found that 75% of the variability in PEFR could be explained by height alone. The predicted PEFR values from our data were also compared with published values from Caucasian and North Indian children and the results are presented in *Table II.* For this purpose we calculated PEFR values at 3 different heights from the prediction equations given by the authors of each paper. It can be seen that our values are similar to those reported for earlier Caucasian as well as North Indian children, but less than the more recent Western values.

A nomogram has been constructed from the linear regression equation, using PEFR as the dependent and height as the independent variable *(Fig).* Since the difference in PEFR between boys and girls at any given height is only 5-7%, we have combined the data for the purpose of the nomogram. This can be used for quick estimation of PEFR at any given height.

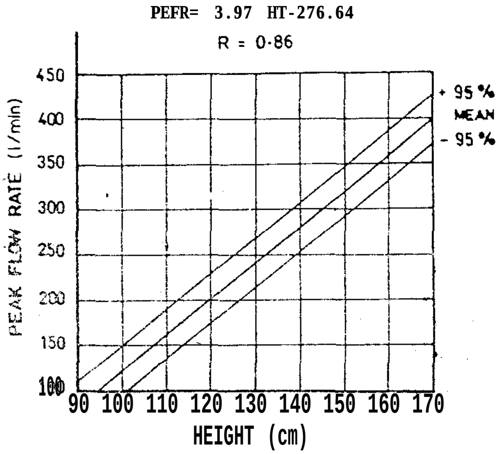

Fig. Nomogram relating PEFR (on the ordinate) to height (on the abscissa). Mean and 95% confidence limits are shown. The regression equation relating height to PEFR is also given.

TABLE II** – **Comparison of PEFR (L./min) Predicted from the Present Series with Those of Previous Studies in Caucasian and North Indian Children

Height (cm)	Godfrey 1970(7)	Wall 1982(5)	Malik 1981(12,13)	Sanz 1990(4)	Kashyap 1992(14)	Swaminathan 1992 (Present)
120						
Male	212	240	222	252	202	205
Female	211	228	216	237	175	193
140						
Male	318	327	320	352	304	286
Female	317	319	314	341	263	272
160						
Male	423	427	418	452	405	368
Female	422	418	412	445	352	350

Discussion

The PEFR has now been accepted as a simple and reliable way of monitoring the severity of bronchial asthma and assessing the response to treatment. The mini Wright peak flow meter is cheap, easily available and its use in Western countries now extends to home monitoring for asthmatics. It should be mandatory for all asthmatics to have a baseline PEFR recorded when they are asymptomatic and clinically free of wheezing and wherever possible, delay or frequent measurements. The daily variations in PEFR can serve as a guide to the severity of asthma, the effectiveness of the current therapy and need for any additional treatment.

It has been shown that pulmonary function, especially lung volumes show racial and ethnic differences(15,16). We wanted to establish the reference values for PEFR for South Indian children of Dravidian stock living at sea level, in a tropical climate. This will be useful when dealing with asthmatic children of South Indian origin as their PEFR measurements can be easily compared to our values. It will also be possible to predict PEFR for a given height from our nomogram or calculate it using known height, weight and age from our equations. It has been shown that, in the absence of a reliable value for height, *e.g.*, in kyphoscoliosis, arm span measurements can be used instead as it correlates very well with height(7).

On comparing our data with previously published Western values, we found that PEFR measurements in South Indian children are lower than those reported for Caucasian but similar to North Indian children of the same height (*Table II*). The difference is marked when one compares recent Western values as there has been a gradual increase in body size and presumably lung volumes as well over the decades in that population. The lower PEFR values in Indian children could be an effect of lower lung volumes due to a smaller chest size as has been reported previously in adults(16). Within India also, ethnic differences have been shown to account for differences in pulmonary function in adults(17) and therefore it is important to establish reference values for each region.

In conclusion, we would like to re-emphasise the value of regular and routine PEFR measurements in asthmatic children in order to monitor their clinical status. We hope that the reference values we have generated for South Indian children will be used and that similar data could be generated for different parts of the country.

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