Factors Affecting Peak Expiratory Flow Rates in Children of 9–12 Years of Age

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Abstract

Introduction: Documentation of peak expiratory flow rate (PEFR) variability may be used to support the diagnosis of asthma and other respiratory disorders. Methodology: This study was carried to measure PEFR of 510 children age group 9 to 12 years of both sexes using a Mini Wright™ Peak Flow Meter. Results were analyzed to find out the normal values of peak expiratory flow rate at each age and either sex. The results were also analyzed to find out what factors influence the peak expiratory flow rate. Effect of age, sex, height, weight, chest circumference, socioeconomic status, passive smoking, cooking fuel, history of contact with tuberculosis and bronchial asthma in family were analyzed separately. Results: The average peak expiratory flow rate in boys was 272±53.16 L/min and for girls was 252±45.09 L/min. For the given age boys have higher peak expiratory flow rate than girls. The peak expiratory flow rate shows very good correlation with height and weight in both sexes. A History of contact with tuberculosis is associated with lower peak expiratory flow rate. Children coming from homes with firewood being used as a fuel and passive smoking had lower peak expiratory flow-rate. No significant relation has been found between peak expiratory flow rate and socioeconomic status and family history of bronchial asthma. Conclusions: The peak expiratory flow rate values of children in study region were comparatively low to those of North Indian and Western children but more compared to urban south Indian children.

Keywords: Peak expiratory flow rate, pulmonary function, asthma, respiratory disease.

Introduction

Respiratory diseases represent the most common cause of death in children worldwide. The number of patients attending the outpatient department of hospital account for only a tip of the iceberg. The technical difficulties inherent in pulmonary function testing of young children are obstacles to the development of simple, clinically relevant procedures for assessment. Even in a time when advanced computerized pulmonary function testing equipment have made their advent. The measurement of peak expiratory flow rate (PEFR) remains a valuable indicator of pulmonary function. Peak expiratory flow rate is a reliable way of judging the degree of airway obstruction in various obstructive lung diseases. The PEFR is an effort-dependent parameter, emerging from the large airways within about 100-120 msec of the start of forced expiration. It remains at its peak for 10 msec [1]. It is well documented in literature that a wide range of geographical, climatic, anthropometric, nutritional, and socioeconomic conditions of India are associated with regional differences in lung function[2].

The variety of durable and inexpensive devices for measuring peak flow rates makes it a valuable tool for monitoring airway diseases in the office or home in the management of asthma [3]. The PEFR can be measured by the patient at home [4]. With proper instruction the results can be used to monitor improvement, intercept early worsening and...
measure response to therapy [5]. A peak flow diary can offer the clinician a longitudinal record by which to evaluate disease activity or therapeutic efficacy. A variation of greater than 20 percent of baseline may indicate increases reactivity.

Prediction equations relating peak expiratory flow rate to height, sex and chest circumferences are available for western children, North Indian children and urban South Indian children. As for any parameter used to assess dysfunction, the importance of having regional reference values cannot be overemphasized. The importance of having reference values for Gulbarga is more so because of the large incidence of respiratory disorders here. This study aims to derive predictive normal values of peak expiratory flow rates in children aged 9 to 12 years in Gulbarga.

Materials and Methods

A total of 510 children with the age of 9 to 12 years of both sexes including 293 boys and 217 girls were selected from class IV to VII of various schools in Gulbarga. Proper consent from the concerned parents and authorities were obtained before the data collection. The children were subjected to a full clinical assessment. Detailed history of cough, expectoration, rhinorrhea and breathlessness were asked. Pediatric reference standard for the lung function were obtained in healthy children who have no present acute or past or present chronic disease of respiratory system, no major respiratory disease such as congenital anomalies, destructive type of pneumonia or thoracic surgery, no more than incidental smoking exposure and no previous URI in preceding three weeks.

Medical information and questionnaire based on the proforma was elicited in local language. Fuel used at home, socioeconomic status (Kuppuswamy’s Classification) [6], history of contact with tuberculosis, history of passive smoking, family history of bronchial asthma and family history of chronic illness were recorded in Performa. Height, Weight, and chest circumference was measured using standard procedure. Peak expiratory flow rate measurements were done using standard mini Wright™ peak flow meter (60-800 l/min). Each child was asked to take a deep breath and blow into the flowmeter and repeated it for 3-4 times until they were familiar with the procedure. The average of three recording was accepted in each case as the peak expiratory flow rate. Care was taken to clean mouth-piece with suitable disinfectant after each recording. The results were statistically analyzed using ‘t’ test and correlation coefficient.

Results

Table-1: Mean and SD of Peak Expiratory Flow Rate according to age.

| Age | No. of subject | Mean PEFR | SD  | P value |
|-----|----------------|-----------|-----|---------|
| 9   | 138            | 217       | 29.44 | P < 0.001 |
| 10  | 136            | 240       | 26.30 | P < 0.001 |
| 11  | 117            | 279       | 29.17 | P < 0.05  |
| 12  | 119            | 274       | 36.72 | P < 0.001 |

It was observed that PEFR increases with age and the increase is statistically significant in all age groups (Table-1).

Table-2: Mean and Standard Deviation of Peak Expiratory Flow Rate according to Age and Sex.

| Age in years | Boys | Girls | P Value |
|--------------|------|-------|---------|
|              | No. of subjects | Mean PEFR | S.D. | No. of subjects | Mean PEFR | S.D. |         |
| 9            | 74   | 225   | 23    | 64   | 209   | 33.18 | P > 0.05 |
| 10           | 73   | 240   | 28.62 | 63   | 240   | 23.57 | P > 0.05 |
| 11           | 71   | 283   | 29    | 46   | 274   | 27.81 | P < 0.001 |
| 12           | 75   | 337   | 36.5  | 44   | 318   | 31.16 | P < 0.05 |

The mean and standard deviation of both sexes of each age was analyzed to find out the difference in PEFR between boys and girls. These results clearly shows boys have PEFR, which is significantly higher in age 11 and 12 years, while in age 9 and 10 years, it is statistically insignificant (Table-2).
Table-3: Correlation Coefficient Values of Peak Expiratory Flow Rate with Weight, Height, Age and Chest Circumference.

|               | Boys          |                | Girls         |                |
|---------------|---------------|---------------|---------------|---------------|
|               | Correlation coefficient | P Value | Correlation coefficient | P Value |
| Height        | 0.82          | < 0.001       | 0.73          | < 0.001       |
| Weight        | 0.81          | < 0.001       | 0.69          | < 0.001       |
| Chest circumference | 0.59      | < 0.001       | 0.52          | < 0.001       |
| Age           | 0.73          | < 0.001       | 0.79          | < 0.001       |

The values of PEFR obtained for boys and girls were analyzed to find out relationship between peak expiratory flow rate and anthropometric measurement of child. Pearson correlation coefficient was computed for PEFR with height, weight, chest circumference and age. It was deduced that height, weight and chest circumference have a good correlation with peak PEFR in boys (Table-3). As for boys, it was noted that even girls have significant correlation of PEFR with height, weight and chest circumference.

Table-4: Mean and standard deviation of PEFR based on socio-economic status, TB in family, smoking in the family, fuel use for cooking and bronchial asthma in the family.

|                   | No. of subjects | Mean PEFR | SD    | P value  |
|-------------------|-----------------|-----------|-------|----------|
| Status            |                 |           |       |          |
| Low               | 230             | 261       | 47.85 | P > 0.05 |
| Medium            | 277             | 265       | 49.03 |          |
| High              | 03              | 258       | 68.50 |          |
| Tuberculosis      |                 |           |       |          |
| H/ O contact with TB | 25            | 233       | 34.07 | P<0.001  |
| No H/O contact TB | 485             | 265       | 51.98 |          |
| Smoking           |                 |           |       |          |
| H/ O contact passive smoking in family | 94          | 250       | 52.90 | P<0.001  |
| No contact passive smoking in family | 416         | 267       | 50.91 |          |
| Fuel used         |                 |           |       |          |
| Firewood          | 243             | 257       | 53.28 | P<0.001  |
| Gas               | 262             | 269       | 48.95 |          |
| Kerosene          | 05              | 221       | 30.60 | P>0.05   |
| Asthma            |                 |           |       |          |
| Family history of Asthma | 55       | 242       | 39.43 |          |
| No family history of Asthma | 455     | 260       | 52.05 |          |

The peak expiratory flow rate of children was analyzed according to their socioeconomic status. As there were only 5 children in the higher socioeconomic group, the number was statistically insufficient for comparison. Hence, mean peak expiratory flow rate was compared between low and middle socioeconomic groups (Table-4).

Children were analyzed to find out any relation between tuberculosis and peak expiratory flow rate. The results state that children with strong history of contact with tuberculosis in their home have significantly lower values of peak expiratory flow rate (Table-4).

Children analyzed were divided into two groups based on exposure to smoking at home. It was found that, there was a significant decrease in peak expiratory flow rate in children with history of exposure to smoking at home (Table-4). In this study fuel used in cooking at home was found to affect peak expiratory flow rate (Table-4). From the history, children were divided again into two groups based on family history of bronchial asthma. It was seen that family history of bronchial asthma does not influence peak expiratory flow rate (Table-4).
Discussion

The study shows an increase in PEFR with age and it was statistically significant in all age group of study population. Other studies by Donaldson GC et al [7], Janssens J et al [8] and Steffen TM et al [9] reported a highly significant correlation between age and pulmonary function. The results of PEFR in both sexes of each age shows that, the boys have higher PEFR, which is significantly higher in age 11 and 12 years, while in age 9 and 10 years, it is statistically insignificant. Hence, overall boys had significant higher mean PEFR than girls. The findings were correlating to other studies such as studies by Peterson ML et al [10], Steffen TM et al [9] and Singh AK et al [11].

The relationship between peak expiratory flow rate and anthropometric measurement of child was confirmed with the separate measurement of PEFR in boys and girls. Boys and girls have significant correlation of PEFR with height, weight and chest circumference. In previous studies, Mohammad zadeh I et al [12] observed the best correlation between PEFR and height. Similar observations were made by Eigen H et al [13], Donaldson GC et al [7] and Pulickal AS et al [14].

Thus, the findings of this study correlate well with other studies that for given age and sex, anthropometric measurement has strong correlation with PEFR. The analysis of peak expiratory flow rate of children according to their socioeconomic status showed no variation in peak expiratory flow rate between both groups. However, Jackson B et al [15] in their study found that, children from low socioeconomic status have lower forced vital capacity.

The results state that the peak expiratory flow rate is significantly lower in children with strong history of contact with tuberculosis in their home. A study by Kosmidis C et al [16] showed that pulmonary tuberculosis can lead to all possible pattern of dysfunction. It has been shown that bronchial compression in tuberculosis can occur by lymph node pressure from outside the bronchus or alternatively perforation of the node may obstruct the bronchus by its contents. In early cases, mild bronchial compression leads to narrow lumen and child can develop wheezing. Thus as obstructive lung disease is possible with tuberculosis; the lower level of peak expiratory flow rate with positive history of contact in the study can be explained and is comparable to the other studies. It was found that, the history of smoking exposure in children at home was significantly decreasing the peak expiratory flow rate. Studies by Palmer CN et al [17] found that maternal smoking connected with significantly lower peak expiratory flow rate, forced vital capacities and lower peak expiratory flow rate in their children. Li YF et al [18] study showed that father’s smoking status during child’s lifetime was linearly related to decrease in predicted values of peak expiratory flow rate and maximum mid expiratory flow in total subjects. The effect was more pronounced in girls. Tsai CH et al [19] showed that respiratory functions were generally lower in household where fathers smoked. Hence, the finding that passive smoking has a significant effect on peak expiratory flow rate correlates well with the western studies. This study shows a relationship between peak expiratory flow rate and fuel used for cooking at home. Air pollution has been shown to cause or aggravate lung function and hence impair pulmonary function in children. In a study by Chhabra SK et al [20] it was shown nitrogen dioxide was associated with lower forced vital capacity, forced expiratory volume and peak expiratory flow rate. As firewood is associated with high combustion and direct contact with smoke and high level of unburnt gases, the decrease in peak expiratory flow rate may be explained. Urom SE et al [21] observed decreased peak expiratory flow rate in Nigerian men and women chronically exposed to fish drying using burning firewood. But whether peak expiratory flow rate was decreased due to burning firewood or dried fish could not be made out due to technical reasons. Hence, it can be said that this study is comparable to other studies.

Study shows no influence of family history of bronchial asthma with peak expiratory flow rate. In his study Smith AD et al [22] found significant variability in peak expiratory flow rate of Asthmatic children while Pellegrino R et al [23] found peak expiratory flow rate of limited value in assessing degree of severity of Asthma during routine clinical work. The present study showed no significance between exposure to bronchial asthma in family and peak expiratory flow rate because of the fact that all
children with clinical features of asthma in past and present were excluded from the study.

**Conclusion**

Determination of peak expiratory flow rate is an inexpensive and simple method of assessing the severity of airway obstruction in a child with obstructive airway disease. It is of considerable value in monitoring disease, prediction of exacerbation and monitoring therapeutic efficacy. Peak expiratory flow rate increases progressively with age in both sexes. For the given age boys have higher peak expiratory flow rate than girls. Peak expiratory flow rate shows very good correlation with height and weight in both sexes. A History of contact with tuberculosis is associated with lower peak expiratory flow rate. Children coming from homes with firewood being used as a fuel had lower peak expiratory flow rate. No significant relation has been found between peak expiratory flow rate and socioeconomic status and family history of bronchial asthma. The peak expiratory flow rate values of children in Gulbarga were comparatively low to those of North Indian and Western children but more compared to urban south Indian children.

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**List of abbreviations**

PEFR- Peak expiratory flow rate, msec- Millisecond, URI-Upper respiratory tract infections

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