IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 6 Ver. IV (June. 2016), PP 30-36
www.iosrjournals.org

To Determine PEFR in Children Aged 8 to 12years in Nellore District

Dr.Kashapogu Archana[1,] ,Dr. Pinnamaeni pawankalyan[2], Dr Sambashiva reddy[3] , Dr Venugopal Sharma[4]

[1]*Senior resident pediatrics , Andhra medical college Vishakapatnam*
[2]*Assistant professor pediatrics, DRPSIMS&RF Chinaoutapally*
[3]*Associate Professor Pediatrics ,Narayana medical college, Nellore*
[4]*Prof & HOD Pediatrics, Narayana medical college, Nellore*

Abstract:
Background: *Peak expiratory flow rate is a widely accepted parameter for the assessment of lung function. It has gained universal acceptance in view of the simple non-invasive technique involved in testing, the wide availability of small portable flow meters and high correlation of values with the standard spirometric values. The PEFR values vary among geographical areas depending on the ethnic race and the local factors. . Hence there is a need to establish the norms of PEFR for each geographic area for reference in clinical practice.*
Objectives: *The aim of this study is to determine the normal PEFR values in urban and rural children of Nellore district of Andhra Pradesh, aged 8-12 years.*
Methodology: *A cross-sectional study was done between June 2011 and March 2012 at Nellore city and surrounding villages with a sample size of 1277children aged between 8-12 yrs*
Results: *The data was analyzed using correlation coefficient, chi-square test and 'p'value. The children were divided into 5 groups Each group was further subdivided into 4 sub-groups i.e., urban boys, urban girls, rural boys, and rural girls. The data in each sub-group of children was interpreted in relation to height, weight and age of child.Normal PEFR value for the given height and age was predicted for males and females separately using Host's formulae 52.66% of urban children had normal PEFRs as compared to their rural counterparts, the difference being statistically significant Among the anthropometric indices, height had the highest correlation followed by weight and age. Girls had lower PEFR values at all given ages than boys in both urban and rural groups. Even after matching for heights and weights, boys had greater PEFR values than girls. The study shows that atmospheric pollution had significantly lowered the PEFR in children. 17.17% of affected children had PEFR values in the normal range as compared to 46.76% of normal children which is statistically significant. In this study, children with history of bronchial asthma in family had significantly lower mean PEFR values even without being affected by the disease than children without such history. Children with personal history of bronchial asthma, though asymptomatic, had significantly lower PEFR values and lesser number of children with PEFR values in the normal range (13.11% Vs 46.76%) than normal children. Children with more than one risk factor among the above had lower mean PEFR values and lower PEFR values in the normal range.*
Conclusion: *PEFR of a child is determined by many factors viz, nutritional status of the child, urban/rural status, exposure to smoke, air pollution, history of bronchial asthma in the family, personal history of bronchial asthma. However, the strongest correlation is seen between PEFR and height followed by weight and age. PEFR serves as a good monitoring tool for patients with bronchial asthma.*
Keywords: *PEFR, 8-12 years, nutritional status, pollution*

I. Introduction

Peak expiratory flow rate is a widely accepted parameter for the assessment of lung function. It has gained universal acceptance in view of the simple non-invasive technique involved in testing, the wide availability of small portable flow meters and high correlation of values with the standard spirometric values. It is a simple and reliable way of following patients with bronchial asthma and other obstructive airway disease in clinical practice as the spirometers are largely confined to the bigger hospitals. Its use now extends to home monitoring of asthmatics. The PEFR values vary among geographical areas depending on the ethnic race and the local factors. Even within India, various studies in different parts of our country showed varying results. Hence there is a need to establish the norms of PEFR for each geographic area for reference in clinical practice. The aim of this study is to determine the normal PEFR values in urban and rural children of Nellore district of Andhra Pradesh, aged 8-12 years.

II. Materials And Methods

The study aimed at determining the normal values of PEFR in urban and rural children of Nellore district of Andhra Pradesh, aged 8 to 12 years. Total 1277 children belonging to 8 -12 year age group were selected. Out of them 748 children were from the Nellore city and 529 children were from Bucchireddy palem, Kovur, Jonnavada villages of Nellore district of Andhra Pradesh. The study was conducted between June 2011 and March 2012.

Age between 8-12 years (97-144 months) and healthy asymptomatic children were included in the study. History of respiratory tract infection within 2 weeks of study, history of chronic respiratory illness or tuberculosis and history suggestive of cardiac disease or any other systemic disease were excluded from the study. Standing height using stadiometer and weight using weighing machine were recorded. A peak flow meter of standard range was used to measure the PEFR of children in this study. Informed consent was taken from their parents through the Principal of each school to enroll their children into the study. Children were educated about the procedure.

The children were divided into 5 groups; Normal healthy children with no history of exposure to smoke, no family history of asthma and no personal history of asthma (Group I). Children with history of exposure to smoke and no other family history of asthma or personal history of asthma (Group II) , Children with family history of bronchial asthma and no other personal history of asthma or history of smoking (Group III). Children diagnosed to have bronchial asthma, which were asymptomatic at the time of study (Group IV). Children with more than one factor among history of exposure to smoke , family history of bronchial asthma and asymptomatic children with personal history of bronchial asthma (Group V) Each group was further subdivided into 4 sub-groups i.e., urban boys, urban girls, rural boys, and rural girls. The data in each sub-group of children was interpreted in relation to height, weight and age of child. The data was analyzed using correlation coefficient, chi-square test and 'p'value.

Normal PEFR value for the given height and age was predicted for males and females separately using Host's formulae[6]:

MALES : (3.8 x Height (in cms)) + (10.6 x Age (in years)) – 313.2

FEMALES: (2.2 x Height (in cms)) + (14.2 x Age (in years)) – 143.

III. Results

In group I, total of 633 children were enrolled into the study which was further divided into 4 study groups – 196 urban boys, 161 urban girls, 152 rural boys and 124 rural girls The mean height, Weight, PEFR and standard deviation for the study group were calculated. The mean height, weight and PEFR for urban boys is 140.6cm, 31.36kg and 319.72L/ min respectively for the age group 97-120 months and 144cm, 33.12kg, 348.9L/min respectively for 121-144months. For urban girls between 97-120months and 121-144months the mean height, weight and PEFR are 139.23cm, 142.79cm, 30.79kg, 32.73kg and 299L/min , 330L/min respectively.

For rural boys the mean height , weight and PEFR for the age between 97-120 months are 137.1cm , 28.74 kg and PEFR is 289.1 respectively whereas for 121-144 months are 142.9cm, 32.13 kg and 320.2 L/min respectively where as for rural girls the mean height weight and PEFR are 134.4cm, 26.51kg and 270.1L/min are for students between 97-120 months and for students between 121-144 months the mean values are 141.2cm , 31.2kg and 302.1L/min respectively.

The relation between height and PEFR, weight and PEFR and age and PEFR were calculated using correlation coefficient and showed they had strong positive relationship. PEFR value for group I i.e., normal children were calculated using the Host's formulae

TABLE –1: PEFR in urban children vs rural children

Study Group	No. of Subjects
Urban Boys	196
Urban Girls	161
Rural Boys	152
Rural Girls	124
Total	633

TABLE-2: Predicted PEFR value

Age Group	Sex	Predicted PEFR value
8-9y	Male	(3.8 x 131.4) + (10.6 x 8) – 313.2= **270.92**
9-10y	Male	(3.8 x 135.6) + (10.6 x 9) - 313.2= **297.48**
10-11y	Male	(3.8 x 139.2) + (10.6 x 10) - 313.2 = **321.45**
11-12y	Male	(3.8 x 143.41) + (10.6 x 11) - 313.2 = **348.35**
8-9y	Female	(2.2 x 125.6) + (14.2 x 8) -143.9 = **246.02**

9-10y	Female	(2.2 x 129.89) + (14.2 x 9) -143.9 =**269.66**
10-11y	Female	(2.2 x 136.92) + (14.2 x 10) - 143.9 = **299.32**
11-12y	Female	(2.2 x 142.18) + (14.2 x 11) - 143.9 = **325.09**

The predicted PEFR values for normal subjects so calculated were utilized for comparing the PEFR values in urban and rural children. Those children with PEFR value less than the predicted value for that mean height, age and sex were classified as "SUBNORMAL" and those values equal to or more than the predicted value were classified as "NORMAL"

TABLE –3: Comparison of PEFR between Urban and Rural children

	Urban	**Rural**	**Total**
Normal PEFR	188	108	296
Subnormal PEFR	169	168	337
Total	357	276	633

The PEFR values of urban and rural children were compared using chi-square test, showed that 52.66% of urban children had normal PEFR values as compared to 39.13% of rural children. The correlation was statistically significant (**p value** < 0.000723.)

In group II, total of 198 children were exposed to smoke, out of which 50 were urban boys, 45 were urban girls, 53 were rural boys and 50 were rural girls. For these children, mean heights and PEFRs were calculated according to age and sex. Predicted PEFR value for the given height, age and sex was calculated using Host's formulae.

c

Age Group (in years)	**Sex**	**Predicted PEFR value**
8-9y	Male	(3.8 x 126.56) + (10.6 x 8) – 313.2=**252.53**
9-10y	Male	(3.8 x 132.87) + (10.6 x 9) – 313.2 = **287.10**
10-11y	Male	(3.8 x 137.38) + (10.6 x 10) - 313.2 = **314.84**
11-12y	Male	(3.8 x 142.26) + (10.6 x 11) - 313.2 = **343.98**
8-9y	Female	(2.2 x 124.26) +(14.2 x 8) – 143.9 = **243.07**
9-10y	Female	(2.2 x 129.86) + (14.2 x 9) – 143.9 = **269.59**
10-11y	Female	(2.2 x 135.67) + (14.2 x 10) - 143.9 = **296.57**
11-12y	Female	(2.2 x 141.38) + (14.2 x 11) - 143.9 = **323.33**

The predicted PEFR values were compared with the predicted PEFR values calculated for the normal children. The PEFR values of normal children were compared to with that of children exposed to smoke using chi-square test, 17.17% of children with history of exposure to smoke had normal values as compared to 46.76% of normal children which is statistically significant (**p value ≤**0.0000001).

TABLE-5: PEFR values Normal children Vs Children with H/o Exposure to Smoke

	Normal children	**Exposure to Smoke**	**Total**
Normal PEFR	296	34	330
Subnormal PEFR	337	164	501
Total	633	198	831

In group III, total of 166 children with family history of asthma were studied, out of which 76 were urban boys, 37 were urban girls, 31 were rural boys and 22 were rural girls. For these children, mean heights and PEFRs were calculated according to age and sex. Predicted PEFR value for the given height, age and sex was calculated using Host's formulae.

TABLE-6: Predicted PEFR value

Age Group (in years)	**Sex**	***Predicted PEFR value***
8- 9 y	Male	(3.8 x 132.94) + (10.6 x 8) – 313.2 = **276.77**
9-10 y	Male	(3.8 x 136.04) + (10.6 x 9) – 313.2= **299.15**
10-11y	Male	(3.8 x 139.23) + (10.6 x 10) - 313.2 = **321.87**
11-12y	Male	(3.8 x 142.89) + (10.6 x 11) - 313.2 = **346.38**
8 – 9y	Female	(2.2 x 128.78) + (14.2 x 8) – 143.9= **253.01**
9 – 10y	Female	(2.2 x 132.45) + (14.2 x 9) – 143.9= **275.29**
10-11y	Female	(2.2 x 136.92) + (14.2 x 10) - 143.9 = **299.32**
11-12y	Female	(2.2 x 141.78) + (14.2 x 11) - 143.9 = **324.21**

The PEFR values of normal children were compared to with that of children who had family history of asthma using chi-square test, 26.5% of children with family history of bronchial asthma had normal PEFR values as compared to 46.76% of normal children, which is statistically significan (**p value ≤**0.000003).

TABLE-7: PEFR values Normal children Vs Children with family H/O bronchial asthma

	Normal children	**Family history of Asthma**	**Total**
Normal PEFR	296	44	340
Subnormal PEFR	337	122	459
Total	633	166	799

In group IV, total of 122 asymptomatic children with history of bronchial asthma were studied, out of which 40 each were urban boys and urban girls, 22 were rural boys and 20 were rural girls. For these children, mean heights and PEFRs were calculated according to age and sex. Predicted PEFR value for the given height, age and sex was calculated using Host's formulae.

TABLE-8: Predicted PEFR value

Age Group (in years)	**Sex**	**Predicted PEFR value**
8-9 y	Male	(3.8 x 128.92) + (10.6 x 8) – 313.2 = **261.49**
9-10 y	Male	(3.8 x 133.28) + (10.6 x 9) – 313.2 = **288.66**
10-11y	Male	(3.8 x 137.43) + (10.6 x 10) -313.2 = **315.03**
11-12y	Male	(3.8 x 141.59) + (10.6 x 11) -313.2 = **341.44**
8-9 y	Female	(2.2 x 124.64) + (14.2 x 8) -143.9 = **243.90**
9-10 y	Female	(2.2 x 130.04) + (14.2 x 9) -143.9 = **269.98**
10-11y	Female	(2.2 x 135.96) + (14.2 x 10) -143.9 = **297.21**
11-12y	Female	(2.2 x 141.03) + (14.2 x 11) -143.9 = **322.56**

The predicted PEFR values were compared with the predicted PEFR values calculated for the normal children The PEFR values of normal children were compared to with that children who had history of asthma using chi-square test, 13.11 % of asymptomatic children with the personal history of bronchial asthma had normal PEFR values as compared to 46.76% of normal children and the correlation is statistically significant (**p value ≤**0.0000001).

TABLE-9: PEFR values Normal children Vs Children with H/O bronchial asthma

	Normal children	**History of Bronchial Asthma**	**Total**
Normal PEFR	296	16	312
Subnormal PEFR	337	106	443
Total	633	122	755

In group V, total of 158 children were found to have more than one risk factor, out of which 57 were urban boys, 46 urban girls, 33 were rural boys and 22 were rural girls. For these children, mean heights and PEFRs were calculated according to age and sex. Predicted PEFR value for the given height, age and sex was calculated using Host's formulae

TABLE-10: Predicted PEFR value

Age Group (in years)	**Sex**	**Predicted PEFR value**
8-9 y	Male	(3.8 x 129.68) + (10.6 x 8) -313.2 = **264.38**
9-10 y	Male	(3.8 x 133.26) + (10.6 x 9) -313.2 = **288.58**
10-11y	Male	(3.8 x 136.79) + (10.6 x 10) -313.2 = **312.60**
11-12y	Male	(3.8 x 140.80) + (10.6 x 11) -313.2 = **327.84**
8-9 y	Female	(2.2 x 126.39) + (14.2 x 8) -143.9 = **247.75**
9-10 y	Female	(2.2 x 131.78) + (14.2 x 9) -143.9 = **273.81**
10-11y	Female	(2.2 x 135.54) + (14.2 x 10) -143.9 = **296.28**
11-12y	Female	(2.2 x 140.54) + (14.2 x 11) -143.9 = **321.48**

The predicted PEFR values were compared with the predicted PEFR values calculated for the normal children The PEFR values of normal children were compared with children who had more than risk factor using chi-square test, that 7.59% of children with more than one risk factor had normal PEFR values as compared to 46.76% of normal children and the correlation is statistically significant (**p value** <0.0000001)

TABLE-10: PEFR values Normal children Vs Children with more than one risk factor

	Normal children	**Children with more than one risk factor**	**Total**
Normal PEFR	296	12	308
Subnormal PEFR	337	146	483
Total	633	158	791

IV. Discussion

In this study the peak expiratory flow rates of 1277 children of Nellore city, and surrounding villages of Nellore District of Andhra Pradesh were determined using a peak flow meter. The study population was carefully selected to represent the entire cross section of the society.

The children were divided into four groups i.e., urban boys, urban girls, rural boys and rural girls. They were further subdivided into various height, weight and age groups. The mean PEFR and standard deviation were calculated for each group separately. The correlation of PEFR with height, age, weight was assessed. The PEFR values of urban and rural children were compared.The effect of various factors i.e. exposure to smoke, family history of asthma and history of asthma on PEFR was assessed. The PEFR values vary between geographical areas depending on the race, the nutritional status and various other factors affecting the local community. Hence, there is a need to establish the norms of PEFR for each geographical area separately. Accordingly, this study has determined the standards of PEFR in normal healthy children in Nellore city, and surrounding villages of Nellore district of Andhra Pradesh. The correlation coefficients of height, weight and age with PEFR were calculated. The p values for comparision between urban and rural children, normal children and children with H/o exposure to smoke, with family H/o asthma, with personal H/o asthma and with multiple risk factors were calculated.

These results were comparable to the results obtained by studies done in other parts of the country like ***Malik et al[1], Behera et al[2]*** and ***Swaminathan et al[3]*** who has done the study in children of South India, but the results were lower than the present study probably because of local factors. In a similar study done by ***Bandhopadhyaya et al[4]*** at Delhi, have shown results similar to the present study in girls.

52.66% of urban children had normal PEFR as compared to their rural counterparts, the difference being statistically significant (CHI-SQUARE value = 11.43, p value <0.000723). This difference can be attributed to the poor nutrition of rural children which is reflected by their anthropometry. Similar results were obtained by ***Rajesh Sharma et al*** **[5] and Jain S.K. et al [6]**, who have compared PEFR values of urban and rural boys of Punjab.

Among the anthropometric indices, height had the highest correlation followed by weight and age. These results were comparable to the results of ***Suhil A. Choh et al[7], Behera et al [2], Pulickal et al[8], Rajesh Sharma et al[5], Swaminathan et al[3], Hergeuner et al [9], Practicia et al [10], Jose Sanz et al [11], Teklu.B. et al[12]***.

Girls had lower PEFR values at all given ages than boys in both urban and rural groups. Even after matching for heights and weights, boys had greater PEFR values than girls. This tells us that anthropometry is only partly responsible for the difference in PEFR between both sexes. Similar results were obtained by ***Host et al [13], Jose Sanz et al [11], Kashyap et al***[14] in Himachal Pradesh also showed that there is significant lowering of PEFR in girls than boys but the results obtained were much lower than the present study.

In a study done in Korea by ***Seo WH et al[15]***, for both sexes, the PEFR increased with height, age, weight, sitting height and body surface area (BSA). Height and BSA were found to be better predictors of PEFR than the other parameters, which correlate well with the present study.

In a study conducted in Wardhan district of Maharashtra, India, by ***Taksnde A et al[16]***, Positive correlation was seen between age, height, weight and PEFR. The regression equations for PEFR were determined for boys and girls separately. The boys had higher values than the girls at all heights and the results correlates well with the present study.

A similar study was conducted in West Bengal, India, by ***Das B.et al[17]*** among child labourers in which PEFR increased with height, weight and age of the children.

It is a well established fact that atmospheric pollution is one of the most important factors affecting pulmonary function. In accordance with this well known fact, this study shows that atmospheric pollution had significantly lowered the PEFR in children. 17.17% of affected children had PEFR values in the normal range as compared to 46.76% of normal children. The difference was statistically significant. (CHI-SQUARE value =77.42, p value <0.0000001) A prospective study done by **Mazur et al** [18] in Poland showed that PEFR dropped by 10% when children were exposed to pollution for more than a year. The fall shown was more than the present study. ***Charpin et al[19], Parthasarathy et al [20],Yun Chul Hung et al [21],Vedal et al [22], Stanley et al [23], Ralph J.Delfino et al[24]*** studies emphasized the effect of atmospheric pollution.

It is generally viewed that children with family history of bronchial asthma need not have lower PEFR if they are not going to inherit the disease. On the contrary, in this study, children with history of bronchial

asthma in family had significantly lower mean PEFR values even without being affected by the disease than children without such history. It indicates that these children are at risk of deterioration if they are subjected to further insult. So, any acute respiratory illness in these children should be viewed cautiously. 26.5% of children with family history of asthma had normal PEFRs which is significantly (CHI-SQUARE value = 21.876, p value =0.000003) lower than 46.76% of normal children.

Children with personal history of bronchial asthma, though asymptomatic, had significantly lower PEFR values and lesser number of children with PEFR values in the normal range (13.11% Vs 46.76%) than normal children(CHI-SQUARE value = 47.73, p value <0.0000001) indicating the need for regular home monitoring of PEFR in these patients for early diagnosis and intervention of an impending acute attack.

Children with more than one risk factor among the above had lower mean PEFR values and lower PEFR values in the normal range (7.59%) than any other group. The difference was statistically significant.(CHI-SQUARE value =81.55, p value <0.0000001).

V. Conclusions

The standard PEFR values of the urban and rural children of Nellore district of Andhra Pradesh have been determined. The PEFR showed strongest correlation with the height of the child followed by weight and age. The urban children had better PEFRs than rural children of corresponding ages. The boys had better PEFRs than the girls at all heights, weights and ages. Children with history of chronic exposure to smoke had lesser PEFR in the normal range than children without such history (17.17% Vs 46.76%) at all heights, weights and ages. Children with family history of bronchial asthma had lesser PEFR in the normal range than children without such history (26.5% vs 46.76%) at all heights, weights and ages. Asymptomatic children with personal history of bronchial asthma had lesser PEFR values than normal children (13.11%) with PEFRs in the normal range. Children with more than one risk factor had 7.59% of their PEFR values in the normal range as compared to the 46.76% of normal children without such history at all heights, weights and ages.

To conclude, PEFR of a child is determined by many factors viz, nutritional status of the child, urban/rural status, exposure to smoke, air pollution, history of bronchial asthma in the family, personal history of bronchial asthma. However, the strongest correlation is seen between PEFR and height followed by weight and age. Therefore, any intervention to improve the pulmonary health of the child should look into aspects like nutritional status, control of air pollution, avoidance of smoking –both active and passive. Also, as it has already been known, PEFR serves as a good monitoring tool for patients with bronchial asthma.

Bibliography

[1] Malik S.K., Jindal S.K. Sharda P.K., Banga N: "Peak expiratory flow rate of school age girls from Punjab (second report)" *Indian Pediatrics.*Vol19: 161-164 Feb-1982.

[2] Behera D, Behera A.K., Malik S.K.: "Peak Expiratory flow rate of school going tribal children 9-15 yrs from Orissa". *Indian Pediatrics.*Vol 25, 623-625,

[3] Swaminathan S, Venkatesan P, Mukunthan R: "Peak Expiratory flow rate in South Indian Children" *Indian Pediatrics* Vol.30: 207-211,1993

[4] Bandhopadhyaya P, Verma S.S, Lakhera S.C., Nand Kishore , Ghadiok A K : "Age and height as predictors of peak expiratory flow rate in Indian girls". *Annals of human biology*, Vol20, No.2, 147-153,1993.

[5] Rajesh Sharma, Anil Jain, Achala Arya, B.R.Chowdary : "PEFR of school going rural children aged 5-14 years from Ajmer District" *Indian Pediatrics* 2002:39:75-78.

[6] Jain S.K., Ramiah T.J., "Lung Volumes and mechanics of breathing in healthy boys 7-14 yrs.old.Norm in healthy boys 7-14yrs.old". *Indian Journal of Chest diseases*, 10:63-68,1968

[7] Suhil A.Choh, Naseer A Choh, Javed Chowdary ; "PEFR in healthy Kashmiri children at high attitude" *Pak Ped J* Mar 2008;28(1):11-4.

[8] Pulickal A.S., Fernandez GVJ: "PEFR in healthy rural south Indian school children predicted from body height": *Indian Journal of Public Health* 2007Apr-Jun: 51(2):117-9

[9] Herguner MO, Gunesher SK, Altamatsl DU, Alparshan ZN, Yilmaz M, Aksungur P, "Peak expiratory flow in healthy Turkish children" : *Acta Pediatrica* Vol86, Issue 5, P:454-455.

[10] Practicia A Agaba, Tom D.Thatcher,Ishaja A.Angyo and Emmanuel I.Agaba : "PEFR in healthy Nigerian children": *Journal of tropical pediatrics* 2003;49(3):157-159.

[11] Jose Sanz, Antonio Martorell, Rosa Saiz, Vincenti Alvarez, Jose I carrasco : "PEFR measured with the Mini-Wright peak flow meter in children": *Pediatric Pulmonology* 1990:9:86-90

[12] Teklu B., Seboxa T, Mills R.J.: "Peak expiratory flow rate in normal Ethiopian children and adults in Addis Ababa", *Br.J.Dis.Chest* 81:176-181, 1987.

[13] Host A, Host A.H, Ibsen T : "Peak expiratory flow rate in healthy children aged 6-17 years"*: Acta pediatrica* 1994 volume 83:Issue 12:P-1255-1257.

[14] Kashyap S, Puri D.S., Bansal S.K.: "Peak expiratory flow rates of healthy tribal children living at high attitudes in the Himalayas". *Indian Pediatrics* Vol.29, 283-286.March1992

[15] Seo WH, Ahn SH, Park SH, Kim J, Ahn KM, Ko BJ, Lee SI.: "The standard range of peak expiratory flow rates of Korean children." Asian Pac J Allergy Immunol. 2011 Jun;29(2):143-9.

[16] Taksande A, Jain M, Vilhekar K, Chaturvedi P. : "Peak expiratory flow rate of rural school children from Wardha district, Maharashtra in India." World J Pediatr 2008 Aug;4(3):211-4.

[17] Das B, Ghosh T, Gangopadhyay S.: "Peak expiratory flow rate among child labourers in West Bengal, India." Saudi Med J. 2008 Nov;29(11):1616-20.
[18] Mazur et al: "Peak Expiratory flow values in children relative to the degree of atmospheric air pollution". *Acta Pediatrica* 84: 203-5, 1995.
[19] Charpin D, Kleisbauer J, Fondarai A, Francheterre A, Viala J, Fondarai J.: "Spirometric effects of air pollution episodes in school children" *Ann.Rev. Respiratory Diseases*;131 Suppl A:170,-1985
[20] Parthasarathy Debray, Jayadeb Misra, Chandradipa Ghosh : "PEFR and Cardiorespiratory fitness of Bengal workers exposed to Dust and Plant source particulate matter": *Indian Journal of Community Medicine* : Vol27, No.4 (2002-10-2002-12)
[21] Yun-chul Hong et al: "Metals in particulate pollutants affect PEFR of school children": *Environmental Health Perspectives*, March 2007.
[22] Vedal S, Schenker MB, Memoz A, Samet J.M., Batterman S, Sperzer F.E: "Daily air pollution effects on children's respiratory symptoms and peak expiratory flow": *American Journal of Public Health*, Vol77, Issue 6, 694-698.
[23] Stanley H.Weiss, Azadeh Tasslimi, Amy Davidow, Kathy Belby, Shahanaz Alimokhtari, Clifford P.Weisel: "Air pollution –Effects on public health, health care costs and health insurance costs" *NJ Clean air council* Apr 13,2005.
[24] Ralph J.Delfino, Henrey Gong, William S.Linn, Ye Hu and Edo D.Pellizzan: "Respiratory symptoms and peak expiratory flow in children with asthma in relation to volatile organic compounds in exhaled breath and ambient air" : *Journal of exposure analysis and environmental epidemiology* (2003)13,348-363.