Original Research Article

Comparative study of seasonal variability in peak expiratory flow rate amongst school children in rural and urban areas

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ABSTRACT

Background: Peak Expiratory Flow (PEF) is a value test for lung function and can be conveniently measured by using relatively inexpensive and portable Peak Flow Meter, identifying and assessing the degree of airflow limitation of individuals. While PEFR is obviously related to factors like age, weight, height, race, gender, it may also be additionally affected by seasons and climate. The purpose of study being to observe seasonal variation in PEFR amongst school going children and to observe peak expiratory flow rate in school going children in urban and rural areas.

Methods: This prospective and comparative study was carried out on total 600 children; with 300 each from rural and urban schools, of age group 10-14 years, both sexes. Peak expiratory flow meter was used for the measurements in the seasons of summer (April to June) and winter (December to February) of the year. The results thus obtained were compiled and analysed.

Results: The mean PEFR value (Litres/min) during summers in the rural children was 243.50(S.D.=16.050) while during winters was 253.63(S.D.=16.934), highly significant (p<0.001); mean PEFR summers in the urban children was 241.50(S.D.=20.530)and during winters was 249.93(S.D.=21.685), again highly significant (p<0.001).
In both rural and urban groups PEFR values increased with increase in height and weight of the children which was found to be highly significant (p<0.001). Girls representation proportion in rural vs urban schools being 49% vs 45%; whereas boys being 51% vs 55% respectively.

Conclusions: Peak expiratory flow rate decreased during summer season of the year in both rural and urban school attending children. In both the groups PEFR values had a direct correlation with height and weight of the children. Rural schools showed more girl student representation than their urban counterparts indicating more awareness for girl child education amongst rural population.

Keywords: Airflow limitation, Children, Peak expiratory flow rate, Rural, Seasonal variability, Urban

INTRODUCTION

Pulmonary Function Tests (PFTs) may act as significant aid in diagnosing and a valuable tool in monitoring patients suffering from respiratory diseases. the first and most common of the pulmonary function test is spirometry. Complete spirometry may provide detail of respiratory system state but the instrumentation for spirometry is expensive. In contrast peak flowmeter is an inexpensive device to measure peak expiratory flow rate and can help in assessing the degree of airflow limitation of individuals.[1]

European Respiratory Society states that PEFR is the maximal flow achieved during the phase of expiration, delivered with maximum force, which starts from the maximum lung inflation level. It occurs about 100 ms after a forced expiration start and peaks for 10 ms.[2] There are various factors that affect the Peak Expiratory Flow Rate (PEFR) such as age, sex, weight, height, race, altitude, exercise, parental smoking, seasons and viral infections.[3-6] Seasonality has been researched because of potential risks to human health, especially in relation to the respiratory system.[7] Summertime particulate air pollution has effect on PEFR and decline in PEFR may be seen in children.[8,9]

The measurement of peak expiratory flow was pioneered by Martin Wright, who produced the first meter specifically designed to measure this index of lung function. Types of peak flow meters: two major types: the low-range peak flow meter for small children between 4 and 9 years of age, and for adults with severely impaired lung function; and the standard-range peak flow meter for older children, teenagers, and adults.[10] A pink city flow meter was developed in India and compared with standard Wright peak flow meter. When peak expiratory and inspiratory flow rates determined by five different pink city flow meters were compared to evaluate inter-product variation, results again showed a highly significant correlation on linear regression analysis.[11]

This study was conducted to observe any seasonal variation in PEFR in school going children and comparing any seasonal variation between rural and urban areas.

The aims and objectives of this study were to determine any seasonal variation in Peak Expiratory Flow Rate in school going children in rural areas and to determine any seasonal variation in Peak Expiratory Flow Rate in school going children in urban areas.

METHODS

This study was carried out on 600 children, 300 children each from urban and rural areas of age group 10-14 years. Both females and males were included. It was a prospective and comparative study.

Inclusion criteria

- Children of both the sexes (male and female) between 10-14-year age group.
- Normal healthy school children of Patiala district.

Exclusion criteria

- Child suffering from asthma or having past history of asthma or wheeze.
- Child with thoracic deformity, or history of ARI within past 2 weeks.
- Child having history of atopic condition like eczema, hay fever or atopic rhinitis.

Study period was from December 2017 to December 2018. Study population includes 600 school going children, 300 children each from urban and rural areas of age group 10-14 years from both the sexes. For this study, schools (in and around Patiala) from urban and rural areas were selected randomly. Permission was taken from principal/headmasters of the institute, 300 students of age group 10-14 years each from urban and rural areas, who fulfilled the inclusion criteria and who did not have any of the exclusion criteria were taken. From each school, targeted samples were selected randomly. Students who fulfilled the inclusion criterion were selected. Peak Expiratory Flow Rate (PEFR) values were noted for the above-mentioned children in summer (April to June) and winter (December to February).

Statistical analysis

Statistical analysis was done by SPSS and tests such as chi-square test, Pearson correlation and Student 't' test Unpaired were used and data was analysed and drawn into tables and figures.

Measurement of PEFR

The Wright's Peak Flow Meter (Air Med, UK) has been used universally to measure PEFR. The dial range is 0-1000 litres/min (lpm) though the ATS recommends a range of 100lpm to <850 lpm (10). The instructions adopted for using the peak flow meter were as follows:

- Take a full deep breath in.
- Hold the peak flow meter horizontally.
- Close the lips tightly round the mouthpiece and blow out as hard and as fast as one can in a short sharp blow with flowmeter still horizontally.
- With such standard procedure, 3 readings are to be taken at a time and the best reading to be considered.
- In case of coughing or failure to perform the procedure, the same will be repeated after a gap of 5 minutes and reassurances to child.

Instrument

Figure 1: The peak flow meter and mouthpiece.

A peak flow meter is a portable, inexpensive, hand-held device used to measure how air flows from your lungs in one "fast blast." In other words, the meter measures your ability to push air out of your lungs.

Peak flow meters come in two ranges to measure the air pushed out of your lungs. A low-range peak flow meter is for small children, and a standard-range peak flow meter is for older children, teenagers and adults. An adult has much larger airways than a child and needs the larger range.
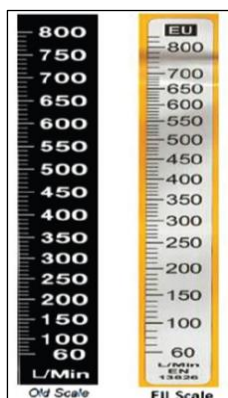

Figure 2: Old Scale vs new EU Scale for Peak Flow Meter (PFM).

Old scale had equidistant markings, while the new EU scale has wide spacing in the lower region and narrower spacing in the middle region (Figure 2). The Mini Wright's PFM is an old device, that has a linear scale with equidistant readings, and has been used to record PEF values for almost three decades. This device was subsequently found to over-read by about 70 L/minute in the middle of the flow range and under-read by about 50 L/minute in the higher flow range. Therefore, in 2004, the scale of this device was replaced with a new 'European Union (EU) scale'. This scale has been shown to be more accurate than the old scale, and as a result, all cylindrical peak flow meters are now recommended to have the EU scale, to ensure accurate readings.

For each subject the recordings were noted in tabulated form in two seasons i.e. summer (April to June) and winter (December to February) and the results were compared and observed for any seasonal variation, and comparison was done for seasonal variation in PEFR between rural and urban areas.

RESULTS

Table 1 shows distribution of the girls and boys in the study population among rural and urban areas. In rural group 147 out of total 300 children were female which accounts for 49% and 153 out of total 300 children were male which accounts for 51%. In urban areas 135 out of total 300 children were female which accounts for 45% and 165 out of total 300 children were male which accounts for 55%.Though in rural group females were

slightly more as compared to urban group but the overall distribution of male and female in urban and rural group was almost similar (p>0.05 i.e. Not significant).

Table 1: Distribution of the girls and boys in the study population among rural and urban areas.

Gender	Rural		Urban		x^2 value	p value
	N	%age	N	%age		
Female	147	49	135	45	0.963	0.326; NS
Male	153	51	165	55		
Total	300	100.0	300	100.0		

Chi-Square Test: NS: p>0.05; Not significant.

Figure 3 show distribution of the girls and boys in the study population among rural and urban areas. In rural group females were slightly more as compared to urban group but the overall distribution of male and female in urban and rural group was almost similar (p>0.05 i.e. Not significant).

In rural group 49% of children were female and 51% were male. In urban areas 45% were females and 55% were males.
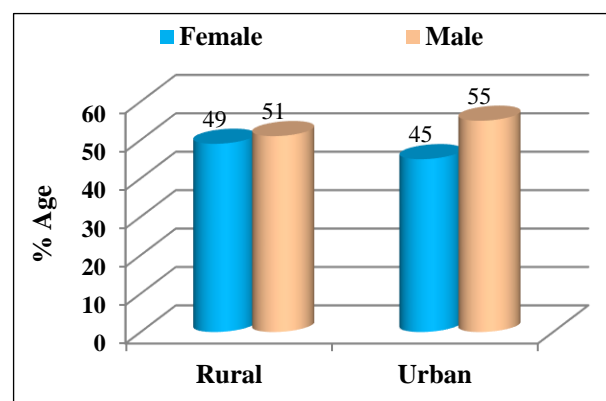

Figure 3: Distribution of the girls and boys in the study population among rural and urban areas.

Table 2 shows correlation of the summer and winter PEFR values with the anthropometric parameters among rural children. There was a correlation between height and PEFR values (both summers and winters) in rural group (highly significant with p value <0.001). A correlation was also observed between weight and PEFR values (both summers and winters) in rural group (highly significant with p value <0.001). However, there was no correlation found between the PEFR values with age.

Table 3 shows correlation of the summer and winter PEFR values with the anthropometric parameters among urban children. There was a correlation between height and PEFR values (both summers and winters) in urban group (highly significant with p value <0.001). A correlation was also observed between weight and PEFR values (both summers and winters) in urban group (highly significant with p value <0.001). There was a correlation between BMI and PEFR values (both

summers and winters) in urban group (highly significant with p value <0.001). However, there was no correlation found between the PEFR values with age.

Table 2: Correlation of the summer and winter PEFR values with the anthropometric parameters (age, height and weight) among rural children.

Rural	Best PEFR Summer		Best PEFR Winter	
	r value	p value	r value	p value
Age	-0.018	0.756	-0.024	0.683
Height	0.572	<0.001**	0.699	<0.001**
Weight	0.355	<0.001**	0.402	<0.001**
Best PEFR summer			0.774	<0.001**
Best PEFR winter	0.774	<0.001**		

Pearson correlation: **p<0.001; Highly Significant

Table 3: Correlation of the summer and winter PEFR values with the anthropometric parameters (age, height, weight and BMI) among urban children.

Urban	Best PEFR Summer		Best PEFR Winter	
	r value	p value	r value	p value
Age	0.008	0.884	-0.007	0.908
Height	0.819	<0.001**	0.881	<0.001**
Weight	0.344	<0.001**	0.377	<0.001**
BMI	-0.284	<0.001**	-0.308	<0.001**
Best PEFR summer			0.927	<0.001**
Best PEFR winter	0.927	<0.001**		

Figure 4 shows seasonal variation of PEFR values among the study population. The mean PEFR value during summers in the rural children was 243.50 and during winters 253.63 (SD=16.934), p value being highly significant (<0.001). The mean PEFR value during summers in the urban children was 241.50 (SD= 20.530) and during winters was 249.93 (SD=21.685), p value being again highly significant (<0.001).

The differences in PEFR values during summers and winters were found to be statistically significant. From the above figure it can also be deduced that PEFR values were higher in rural group as compared to urban group.

Table 4 shows socio-demographic profile and best PEFR of the study population among rural and urban areas the differences in the age distribution and other sociodemographic parameters i.e. height, weight, BMI among the rural and the urban groups were not found to be statistically significant (p values=0.059, 0.341, 0.758, 0.356 respectively) in the rural and urban groups. The difference in the best PEFR values during winters among both groups was statistically significant using unpaired student 't' test (p=0.020) with the higher value in the

rural group (253.63) as compared to the urban group (249.93). However, the differences in the best PEFR values during summers among two groups was not found to be statistically significant (p=0.184).
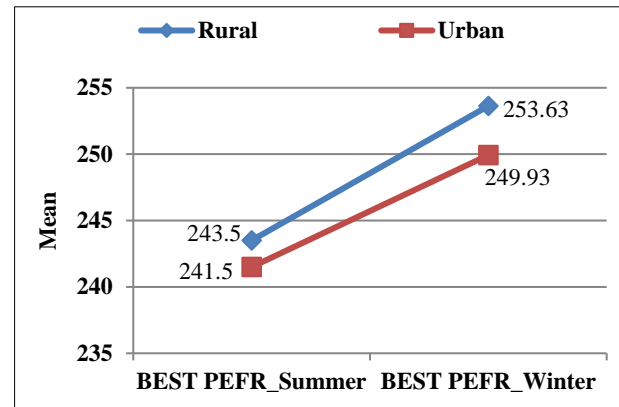

Figure 4: Seasonal variation of PEFR values among the study population.

Table 4: Socio-demographic profile and best PEFR of the study population among rural and urban areas.

	Rural		Urban		p value
	Mean	±SD	Mean	±SD	
Age	11.41	1.089	11.58	1.111	0.059
Height	141.86	3.063	141.62	3.269	0.341
Weight	38.53	2.472	38.47	2.289	0.758
BMI	19.13	1.032	19.21	1.052	0.356
Best PEFR summer	243.50	16.050	241.50	20.530	0.184
Best PEFR winter	253.63	16.934	249.93	21.685	0.020*

Student 't' test Unpaired: *p<0.05; Significant

DISCUSSION

Majority children (N=205; 34.2%) were aged 11 years in both urban and rural group followed by children aged 12 years (N=174; 29%). 11.7 % and 5.7% children were aged 13 and 14 years in both groups. The difference in the age wise distribution of children among rural and urban areas was not statistically significant. In rural group, 49% of subjects were female and 51% of subjects were male which was also seen in study by Paramesh H in 2003 in which a total of 5477 normal children were selected for the study, 2838(51.8%) were boys; 2639(48.2%) were girls.[12]

In urban areas 45% of subjects were female and 55% of subjects were male i.e. males were more compared to females. The differences in the age distribution and other sociodemographic parameters i.e. height, weight, BMI among the rural and the urban groups were not statistically significant (p values=0.059, 0.341, 0.758, 0.356 respectively). The difference in the best PEFR

values during winters among both groups was statistically significant using unpaired student 't' test (p=0.020). However, the differences in the best PEFR values during summers among the two groups was not found to be statistically significant (p=0.184). Mean age in rural and urban groups in study population which is 11.41 in rural group and 11.58 in urban subjects. In a study by Manjunath in 2013 it was concluded that there was no correlation found between the PEFR values and the age.[13] Mean height in rural and urban groups in study population which is 141.86 in rural group and 141.62 in urban subjects. Mean weight in rural and urban groups in study population which is 38.53 and 38.47 respectively. Mean of best PEFR summer in rural and urban subjects was 243.5 and 241.5 respectively as supported by study by Vieira in 2012 who found that exposure to higher levels of NO_2 and O_3 i.e. urban air pollutants was associated with increased risk for asthma and pneumonia in children and decreased lung function.[14] These results were also supported by studies like Samatha Sonnappa, PJA. Burt.[15,16] Mean of best PEFR winter in rural and urban subjects was 253.63 and 249.93 respectively. Vieira found that exposure to higher levels of NO_2 and O_3 i.e. urban air pollutants was associated with increased risk for asthma and pneumonia in children and decreased lung function, the observations being similar as found in the present study.[14] However, a study by P J A Burt showed that children at the urban site produced consistently better average lung function results during winters, whereas at the rural site ,there was generally no relationship between pollen counts and lung function; such findings were also supported by study by Samatha Sonnappa.[15,16]

This study findings with poor PEFR values found during summer season amongst children than the winter, were found to be statistically significant (p<0.001) as supported by studies by Debalina Sahoo, Hosne Ara Ferdousi, Składanowski, Manjunath CB and Strachan Paul.[2,13,17-19] Such decreased PEFR values during the summer season of the region (April to June) in both rural and urban children, in the present study were probably attributable to dry and hot climate in this region during this period, with outside temperature rising to 470ºC or more at occasions; thus affecting the respiratory functions along with its ill effects on the other organ body systems too. In a study by Gultyaeva VV which showed that minimum value of respiratory parameters were found in the spring and the maximum--in the autumn.[20] Hosne Ara Ferdousi and Strachan Paul found a positive correlation in PEF variability between the two seasons, consistent with this study findings.[18,19] The correlation of height and weight with summer and winter PEFR value among rural and urban children was found to be highly significant(p value <0.001) as supported by studies by Składanowski, Kaur Harpreet and Manjunath [showed significant linear correlation of PEFR with height in boys (p<0.001, r=0.7624) and in girls (p<0.001, r=0.8825)].[2,13,21] However, no correlation was found by Manjunath CB et al, between the PEFR values and the age.

CONCLUSION

The values were lower in summer season in both rural and urban groups. Thus, such seasonal variability to be considered whenever evaluating the pulmonary function tests in any given situation or suspected disorder amongst such population groups. Another drawn inference being that a direct proportional rise in PEFR values with increasing height and weight is a physiological feature. As a corollary, another outcome being more girl children representation in schools of rural areas than those in the urban, signalling a paradigm shift in societal psyche change favouring girl childcare and education, an elating social transformation. However more such studies related to different seasons, regions and setups will add to the data and furthermore enlighten the scientific community on the subject.

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