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Original Research Article

Evaluation of Acute Exacerbation of Asthma using Peak Expiratory Flow Rate and Modified Pulmonary Index Score in Children of Age Group 6-18 Years

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Conflict of interest: Nil

Abstract:

Asthma is the most common childhood disease and is rising in developing countries. The accessibility of latest diagnostic methods helps to improve knowledge of the pathophysiology of bronchial asthma. Interaction between genetic and environmental factors is seen to influence development of asthma. The assessment of severity of asthma is essential to decide the initial treatment and to know response of therapy later on. In emergency room, major drawback to attend acute asthma patient is non-availability of special equipment for spirometry and well-trained staff for performing the test and subsequent interpretation of results, so in such cases PEFR used for severity assessment. Other asthma scoring systems are being used that club together physical signs. These include respiratory rate and accessory muscles use in younger children and children with severe airway obstruction. In these patients it is not easy to perform both Spirometry and PEFR as they have difficulty in performing expiratory maneuvers. There are up to 16 severity scoring systems. Most of them use parameters like the blood gas analysis and others require challenging parameters such as inspiratory /expiratory ratios. Hence, for children with acute asthma exacerbation, mPIS provides an easy tool for assessing the severity.

Inclusion Criteria:

1. 6-18 years aged Children with mild to moderate Exacerbation of asthma.
2. Children 8 years and above and Parents willing to give signed informed consent.

Exclusion Criteria:

1. Refusal of consent.
2. Conditions affecting the pulmonary function like immunosuppressive, cardiac & neurological condition.
3. Children with Chronic pulmonary disease.
4. Acute respiratory infection.
5. Children who are not able to perform peak expiratory flow rate.

Results: The mean predicted PEFR improved with treatment by 15.26% (from 112.7% to 172.9% of predicted) ($p<0.0001$) at 15 min. The mean mPIS improved by 4.2 (from 5.5 to 1.31) ($p<0.0001$) at 15 min. Pre & post-treatment mPIS's were significantly correlated with PEFR. The correlation of pre-treatment PEFR and mPIS is $r = -0.534$ ($p=0.000$), that for post-treatment at 15 min is $r = -0.403$ ($p=0.000$).

Conclusion: The mPIS is a handy method for evaluation of airway obstruction. This has higher post-treatment association for smaller airway obstruction than larger airway obstruction. This is a better method to evaluate the mild severity of the disease. It also helps to know treatment response. Most scoring systems are imperfect. So, when spirometry testing & PEFR can't be performed some alternate technique of checking the severity is necessary. The mPIS appears to be easy tool for the evaluation of airway obstruction. It can be used to asses post-treatment response and to standardize the treatment protocol.

Keywords: Modified pulmonary index score (mPIS), Peak expiratory flow rate (PEFR), mini-Wright peak flow meter, Acute exacerbation of asthma.

Introduction

Bronchial asthma is chronic childhood disease. Recurrence of asthma in children is commonly observed. Prevalence of asthma is raised in developing countries according to many epidemiological studies and India is no exception. Asthma can strike at any age, although it usually begins in childhood. The prevalence has raised to nearly 20-30 % in many parts of our country. Since the onset of asthma is linked to both heredity and the environment [1], modifiable environmental factors have

been examined as potential preventative targets. In developed countries, the production of allergen-specific IgE, is a significant risk factor if it starts in early childhood [2]. Development of asthma is influenced by genetic and environmental factors which lead to airway hyper-responsiveness with structural and functional changes in the airways [3].

Need For Study: To decide early treatment and to know response to further therapy, it is important to know the severity of asthma. In emergency room, major disadvantage is non-availability of special equipment like spirometry, well-trained staff for performing it and to interpret it. Hence PEFR indicates the degree of airway obstruction. In children, belonging to any age group, with severe obstruction, both Spirometry and PEFR are difficult to perform. Therefore, numerous asthma scoring systems are established which includes respiratory rate, accessory muscle use and other physical signs to form collective score which determines the severity of exacerbation. There are Around 16 severity scoring systems exist but most of them are burdensome to use as some require the blood gas analysis, objective measures or challenging assessments like inspiratory/expiratory ratios.

Aim and Objectives

1. To study the effectiveness of mPIS in assessing the severity of acute exacerbation of asthma in comparison to PEFR.
2. Clinical assessment of the mPIS with PEFR in measuring the outcome of management of acute exacerbation of asthma.

Review of Literature

Buyuktiryaki AB et al conducted a study with 304 patients in 2013 aged 5–18 years in 3 months' time. Evaluation was done at the initial presentation, 1st and 4th hours. 51.3% needed oral corticosteroids and 19.4% needed hospitalization.

Study proved that Using mPIS and a cut-off value ≥ 5 at the 1st hour to determine attack severity may aid clinicians in EDs. With only a few variables and the capacity to produce a quantitative result, mPIS is a simple tool in clinical practice [4].

In 2014 Maekawa T et al enrolled 25 children (median age of five years) to check 2 components of mPIS: inter-rater reliability and internal consistency by having 2 physicians and nurse with excellent inter-rater reliability. Study concluded that the mPIS was a reliable technique for assessing in children five years and under [5]. In 2014 a study was done using 50 children by Chandrakala P et al. Both before and after treatment PEFR and PS were assessed at different times mainly 5, 10 and 15 min. PEFR and PS scores were compared and study data supported construct validity as well as criterion validity of the PS. When PEFRs is difficult to get in very young or sick children, the PS is a useful replacement for estimating airway blockage [6].

T. Koga et al in 2015 studied 87 asthmatic patients and evaluated quantitative estimation of asthma exacerbation using mPIS. The mPIS at hospitalization had good correlation with the period until discharge. So, it's a good interpreter for assessing the clinical course after hospitalization. Finally mPIS could be a promising clinical scoring system in treatment plan and prediction of hospitalization period [**7]**.

In 2020, Jerry C et al did a review to study the measures acquired in asthma severity scores. Included studies used extractable severity measures to look at the asthma exacerbations severity in children aged 5-18years. There were sixteen eligible publications with seventeen asthma severity scores. Combinations of 15 different factors were used to determine severity scores. Currently, 23 centers assess these scores, but only few uses standard published score. Study concluded stating infrequent use of Standardized published pediatric asthma severity scores [8].

Asthma: It is a common lower respiratory disease with variable airflow obstruction and hyper responsiveness respiratory bronchioles. Symptoms are: repeated episodes of shortness of breath, cough, and wheeze and chest tightness [9].

Definitions of Asthma often includes: *Timing of symptoms *Triggers; *Specific cell types (eosinophils, mast cells); * Reversibility (often). The severity of disease can vary from minor to life-threatening. Asthma management is now assessed by how well current symptoms are controlled as well as the likelihood of potential morbidity [10].

Definition of Asthma [exacerbation: It is the progressive increase in asthma symptoms with airflow obstruction [10].

Table 1: Assessment of Exacerbation Severity [10]

	Mid	Moderate	Severe	Very Severe
Wheeze	Variable	Moderate to loud	loud on inhalation & exhalation	Often quiet
Breathlessness	walking	At rest	At rest/sits upright	
Speaks in	Sentences	Phrases	Words	Unable to speak
Accessory muscle	No	Common	Marked	Paradoxical
Consciousness	Not affected	Not affected	Agitated, confused	
Respiratory rate	Slightly increased	Increased	Highly increased	Undetermined

Pulse	<100	<140 (by age)	>140	Bradycardia
PEF (%)	>10-70	40-70	<40	>25
$Sa0_2$ (% on air)	>94- 95	90-95	<90	
PCO_2 (mmHg)	<42	42	≥42	

Peak Flow Meter: Small portable instrument for measuring how rapidly a person can expel air out of the lungs by blowing a quick blast of air after maximum inhalation and this is called as peak expiratory flow" (PEF). The peak flow meter helps to know the severity of obstruction.

Dr Martin Wright introduced the first meter designed to determine this index of lung function (PEF) in the late 1950s, and then later developed portable and lower-cost version (the Mini-Wright peak flow meter) [11].

Figure 1: Peak Flow Meter [11]

A peak flow meter (Figure 1) is made of following:

- Housing with channel and a pointer.
- Two or more indicators adjacent to the scale which moves parallel with the channel.

Peak flow meter has following uses:

- For diagnosing asthma.
- Variability: Asthma shows diurnal Variation of 15% of established maximum.
- Bronchodilator response: shows response greater than 15% in PEF.
- Exercise testing: asthma shows reduction of PEFR more than 15%.
- Occupational asthma: decreases PEFR over many days and it fails to recover.
- Monitoring progress of disease & developing improvised plan for Self-management.

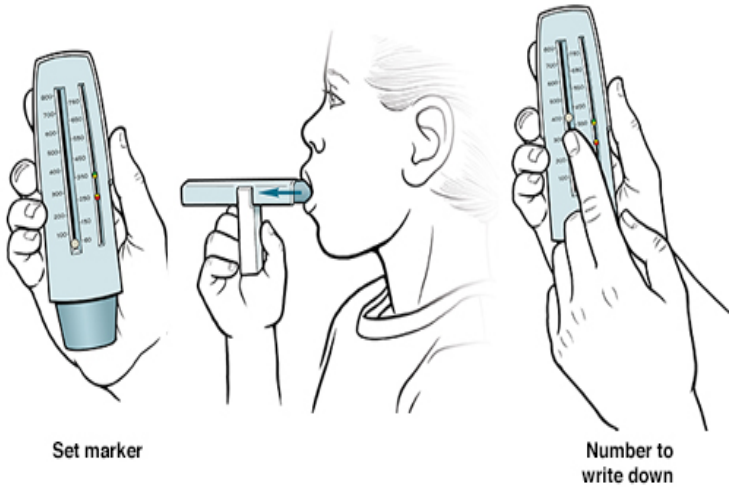

Figure 2: Technique to Use PFM [11].

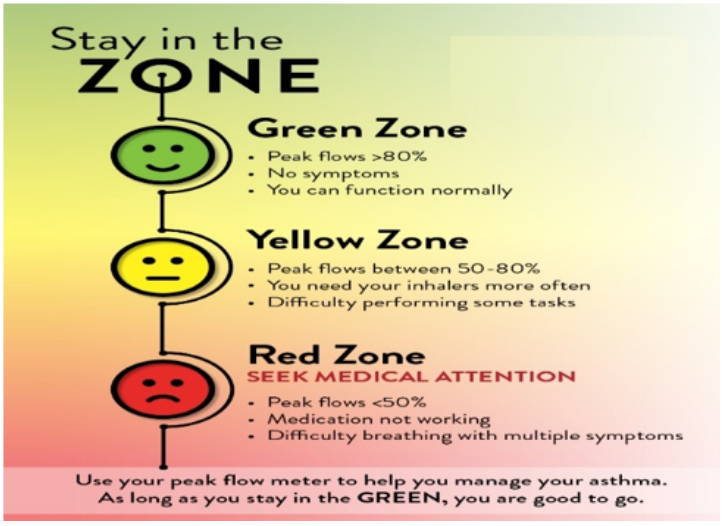

Figure 3: Asthma Action Plan

Simplified outpatient management algorithm for escalating medications [11]. (Adapted from BO Adeniyi and GE Erhabor March 2011)

Pulmonary Scoring System: Objective evaluation of asthma severity, which is assessed by PFT's likes PEFR and spirometry, is vital in setting successful guidelines for management of acute asthma. These tests are difficult to conduct in preschool-aged children and in 35%-50% of school-aged children due to:

1. Severity of the disease. 2. Poor training / experience with the procedure.

With preschool-aged children accounting for more than half of all patients treated for acute asthma, three-quarters expected to be unable to perform normal lung function tests. Finding substitute tests in subjects between 2-17 years is critical for implementation of asthma guidelines. Clinical scores would be simple and low-cost technique. There have been over 18 clinical scores recorded to evaluate acute asthma but they were produced without formal validation.

Cross- sectional study conducted at Chettinad Hospital and Research Institute for a period of 18 months in children between 6years to 18years of age who were confirmed cases of Asthma. Written informed consent for research was obtained.

Inclusion & Exclusion Criteria: as mentioned above in abstract.

Sample Size: 75 patients who fulfill the inclusion criteria.

Sample size calculation is done based on the incidence rate.

$$n = Z^2 p (1-p) / d^2$$

Where: n = Sample size. Z = Z statistic for a level of confidence= 1.96

P = Expected prevalence of proportion (the expected prevalence is 5% [12]).

d = Precision (If the precision is 5%, then d=0.05)

Materials and Methods:

Known asthmatic children of age group 6-18 years presenting with acute asthma exacerbation to CHRI Paediatric department will be selected. Before starting treatment and after treatment at 5,10 and 15 minutes they will be evaluated by measuring PEFR and mPIS. The mPIS is calculated by 6 variables, each variable is given with 4 scores - 0, 1, 2, 3 & maximum total score upto 18.

Table 2: Modified Pulmonary Index Score

SC	RR/MIN	Wheeze	Accessory Muscles	HR /MIN	$SPO_{2\%}$	In-Ex Ratio
0	≤20	None	None	≤100	≤96	2:1
1	21-35	End expiratory	Mild	101-120	93-95	1:1
2	36-50	Inspiratory and expiratory wheeze, good aeration	Moderate	121-140	90-92	1:2
3	>50	Inspiratory and expiratory wheeze, decreased aeration	Severe	>140	<90	1:3

Results

75 children were evaluated, ranging from 6to 18years with a mean age of 9.81±0.2 years. PEFR and mPIS were evaluated before and after treatment at different times for each patient (5, 10 and 15 minutes). Strong change in PEFR and mPIS before and after treatment (Table 3); the mPIS should reduce and the PEFR should rise.

Table 3: Mean and SD of PEFR and MPIS (N=75).

	PEFR					mPIS				
	Before Treatment	At 5 Min	At 10 Min	At 15 Min	At discharge	Before treatment	At 5 min	At 10 Min	At 15 min	At Discharge
Mean	112.7	138.04	142.04	159.4	172.9	5.56	3.98	3.09	1.84	1.31
SD	4.3	5.4	5.6	4.8	7.14	0.5	0.4	0.4	0.3	0.23

The mean predicted PEFR improved with treatment by 15.26% from 112.7% to 172.9% of predicted ($p < 0.0001$) by 15 minutes. The mean mPIS improved by 4.2 ($p < 0.0001$) from 5.5 to 1.31 by 15minutes.

Table 4: Paired T Test for Construct Validity (N=75).

Paired Variables	T-Value	P-Value
PEFR before treatment and PEFR at 5 minutes	-26.23	0.000
PEFR before treatment and PEFR at 10 minutes	-13.17	0.000
PEFR before treatment and PEFR at 15 minutes	-67.13	0.000
PEFR before treatment and PEFR at discharge	-34.43	0.000
mPIS before treatment and mPIS at 5 minutes	45.24	0.000
mPIS before treatment and mPIS at 10 minutes	32.32	0.000
mPIS before treatment and mPIS at 15 minutes	29.12	0.000
mPIS before treatment and mPIS at discharge	24.01	0.000

There was strong negative correlation between PEFR and mPIS. Correlation of: pre-treatment PEFR and mPIS is $r = -0.534$ ($p = 0.000$) (Fig. 4), post treatment at 5 minutes is $r = -0.499$ ($p=0.000$) (Fig 5), at 10 minutes is $r = -0.512$ ($p=0.00007$) (Fig 6) and at 15 minutes is $r = -0.403$ ($p = 0.000$) (Fig.7).

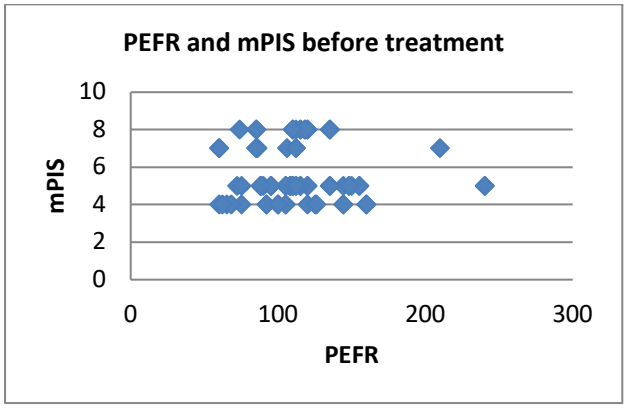

Figure 4: PEFR and mPIS before treatment

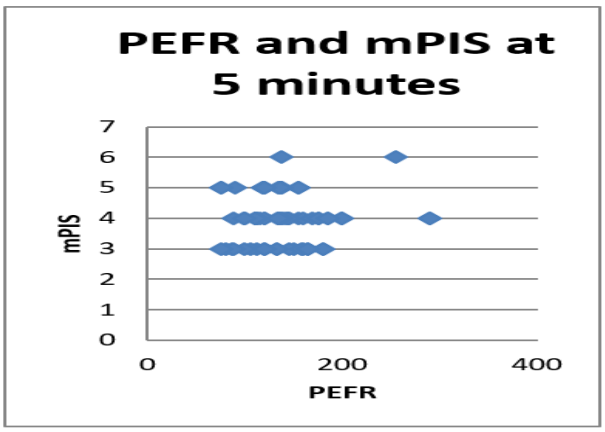

Figure 5: PEFR and mPISat 5 minutes

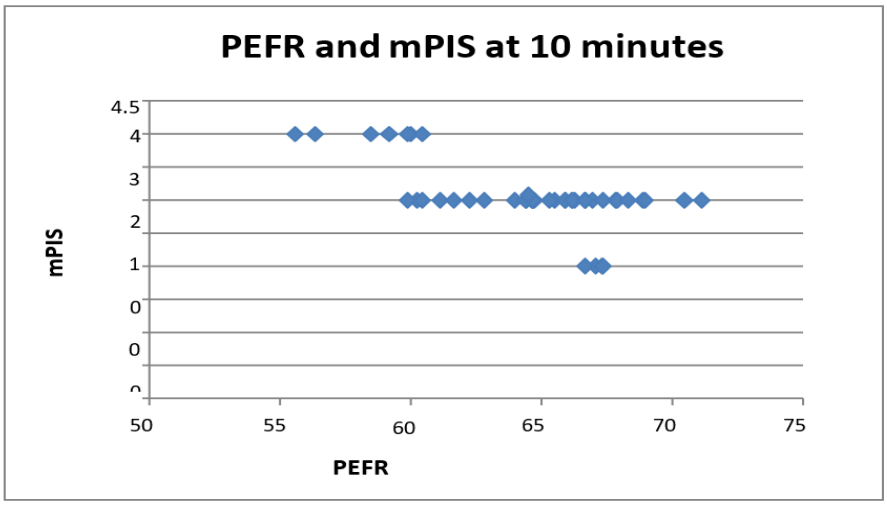

Figure 6: Scatter Diagram for Pefr and Mpis at 10 Minutes (N=75).

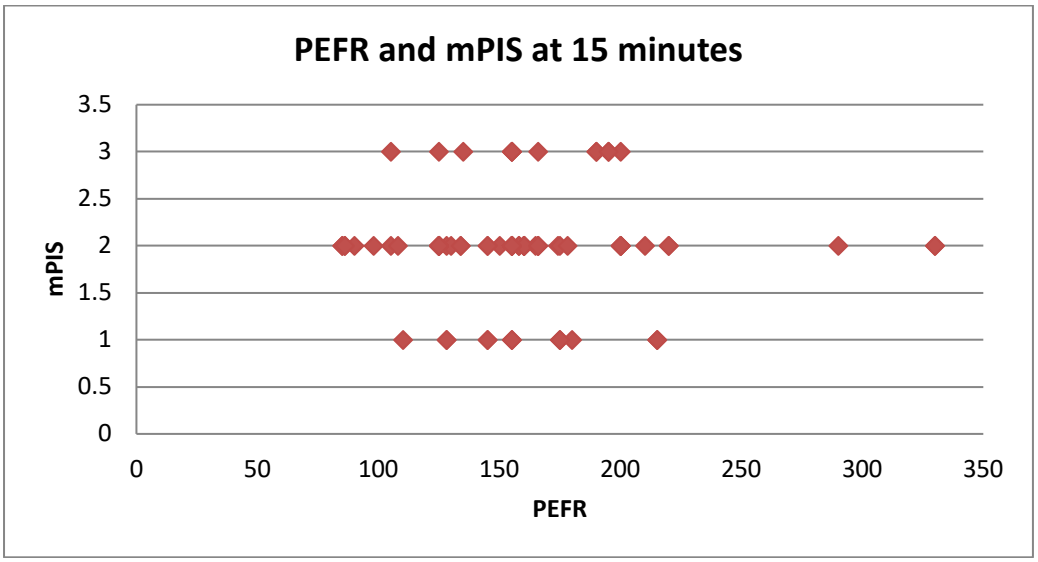

Figure 7: Scatter Diagram for Pefr and Mpis at 15 Minutes (N=75)

Table 5: Age Distribution with Sex (N=75).

Age (Yrs)	Male	Female	Total
6-9	17(22.8%)	18(24%)	35(46.8%)
10-15	22(29.4%)	14(18.6%)	36(48%)
>15	3(4%)	1(1.3%)	4(5.3%)
Total	42(56%)	33(44%)	75(100%)

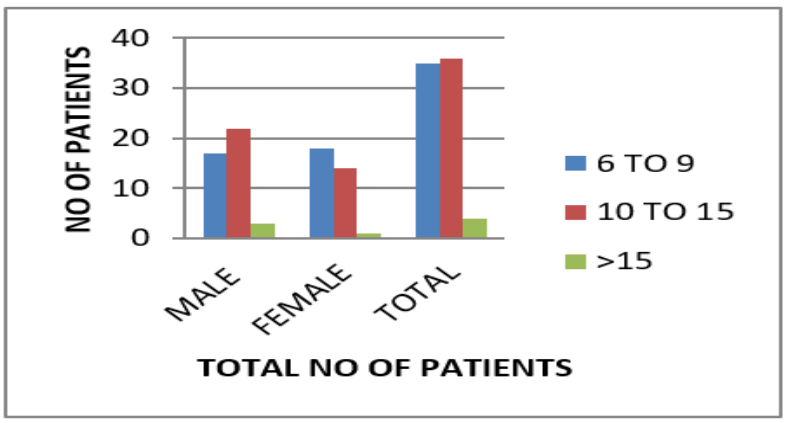

Figure 8: Bar Chart Distribution of Age with Sex (N=75).

In our study males constituted 56% (n=42) and females constituted 44% (n=53) among the study group. There is equal distribution of cases between 2 age groups of 6-9 years (46.8%) and 10-15 years (48%). Only 5.3% (n=4) of cases were >15 years old.

Table 6: Distribution of Se Status (N=75).

Socioeconomic Class	
Upper	2(2.6%)
Upper Middle	9(12.2%)
Upper Lower	17(22.6%)
Lower	30(40%)
Lower Upper	15(20%)
Middle Lower	2(2.6%)
Total	75

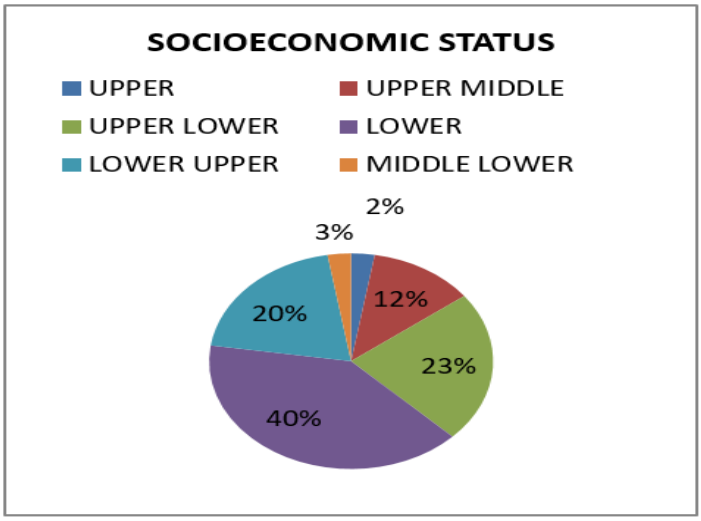

Figure 9: Pie Chart of Distribution of Socioeconomic Status (N=75).

In our study according to modified Kuppuswamy classification, majority 40% (n=30) of cases belong to lower socioeconomic status, 2.6% (n=2) belonged to upper class, 12.2% (n=9) belongs to upper middle class, 22.6% (n=17) belongs to upper lower class, 20% (n=15) belongs to lower upper class, 2.6% (n=2) belongs to middle lower class.

Table 7: Number of Days Missed In School in Last 12 Months (N=75).

1-2 Days	30(40%)
3-5 Days	11(14.6%)
6-9 Days	11(14.6%)
10-14 Days	13(17.4%)
>15 Days	10(13.4%)
Total	75(100.0)

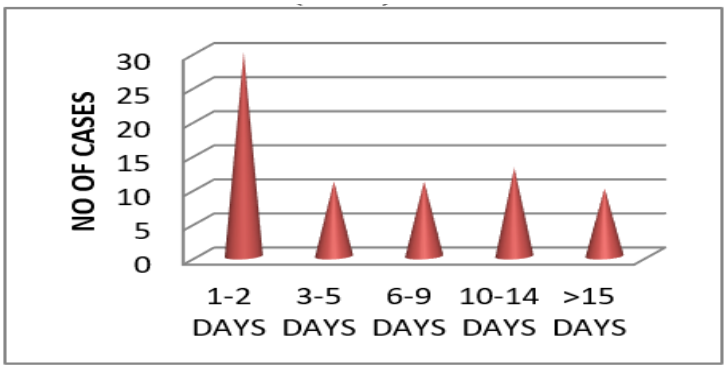

Figure 10: Funnel Bar Chart of Days Missed In School in Last 12 Months (N=75).

In our study, majority of children 40% (n=30) missed only 1-2 days of school and only 13.4% (n=10) children missed school for more than 15 days.

Table 8: Number Of Times Child Treated In Last 12months (N=75).

1 Time	26(34.6%)
2 Times	19(25.4%)
3 Times	12(16%)
4 Times	5(6.6%)
5 Or More	13(17.4%)
Total	75(100.0)

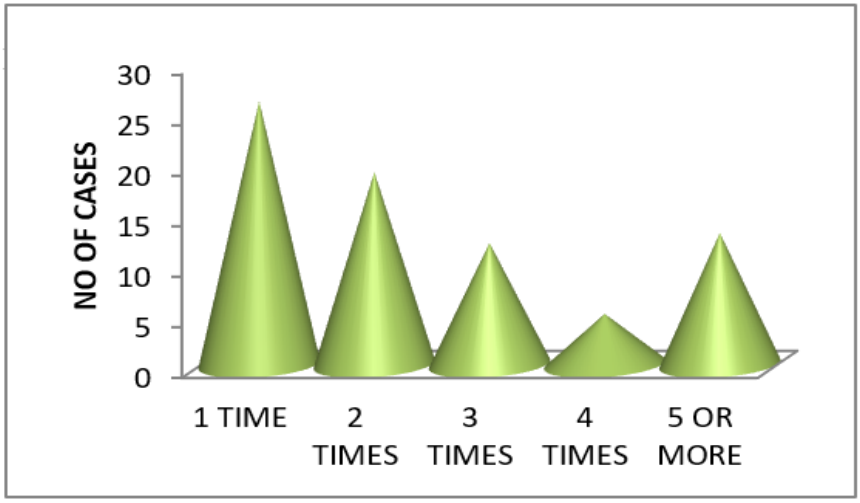

Figure 11: Funnel Bar Chart of Number of Times Child Treated In Last 12 Months (N=75).

In this study, 60% (n=45) of cases have taken 1-2 times treatment in ED and only 17.4% (n=13) cases had taken treatment for > 5 times.

Table 9: Number Of Times Child Being Hospitalised Overnight Or Longer In Last 12 Months (N=75).

1 Time	34 (45.3%)
2 Times	17(22.6%)
3 Times	8 (10.6%)
4 Times	12(16.0%)
5 Or More	4(4.3%)

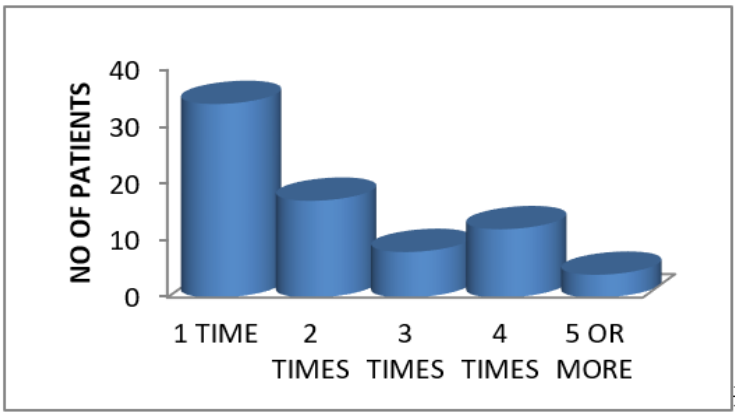

Figure 12: Cylinder Bar Chart: Number Of Times Child Being Hospitalised Overnight Or Longer In Last 12 Months (N=75).

In this study, 45.3% (n=34) cases were admitted once in the last 12 months, 22.6% (n=17) cases were admitted twice, 10.6% (n=8) cases were admitted thrice, 16% cases (n=12) admitted 4 times in the last 12 months and 4.3% cases (n=4) were admitted for 5 or more times in 1 year.

Table 10: Incidence of Previous Attacks (N=75).

Intermittent	32(42.6%)
Mild Persistent	24(32%)
Moderate Persistent	10(13.4%)
Severe Persistent	9(12%)

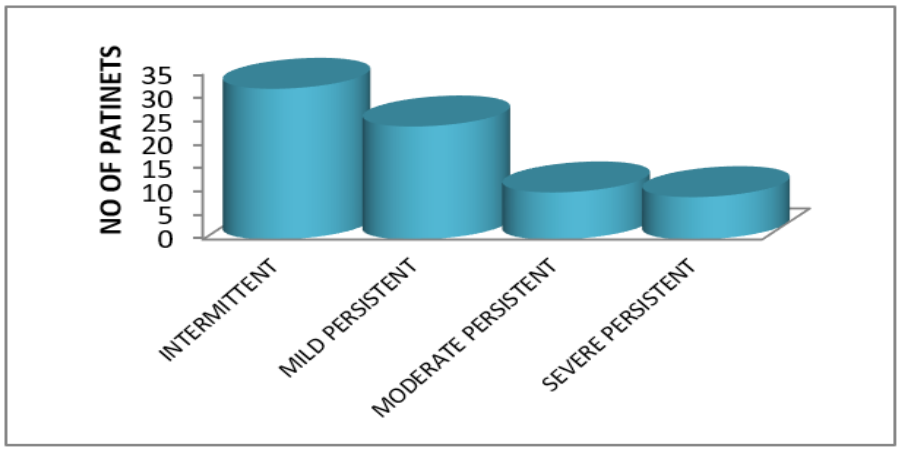

Figure 13: Cylinder Bar Chart of Incidence of Previous Attacks (N=75).

In our study, 42.6% (n=32) of cases had intermittent type and 32% (n=24) of cases had mild persistent type of asthma, 13.4% (n=10) cases had moderate persistent and12% (n=9) had severe persistent asthma.

Table 11: Triggering Factors (N=75).

Dust	39(52%)
Smoke	4(5.4%)
Exercise	12(16%)
Food	10(13.3%)
Chalk Dust	10(13.3%)

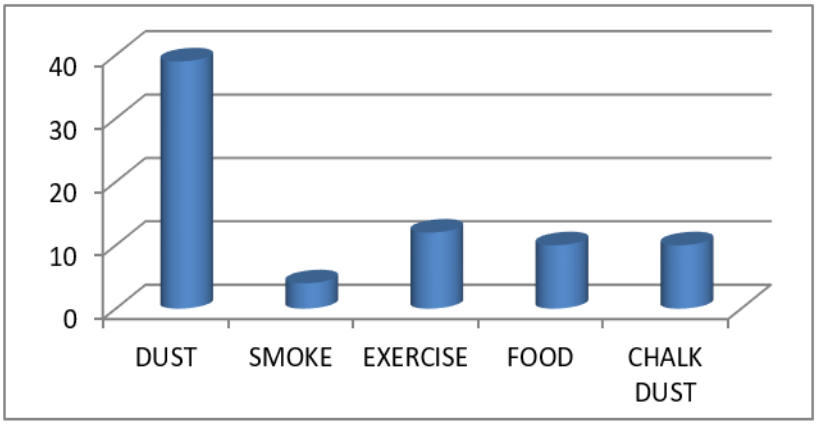

Figure 14: Cylinder Bar Chart of Triggering Factors (N=75)

In this study, dust 52% (n=39) constituted the major triggering factor. Other triggering factors were smoke 5.4% (n=4), exercise 16% (n=12), chalk dust 13.3% (n=10), smoke 10% (n=5) and food 13.3% (n=10)

Table 12: Seasonal Variation (N=75).

Rainy Season	51(68.0%)
Winter	48 (64.0%)
Spring	18(24.0%)
Summer	8(10.7%)
All Seasons	7 (9.3%)

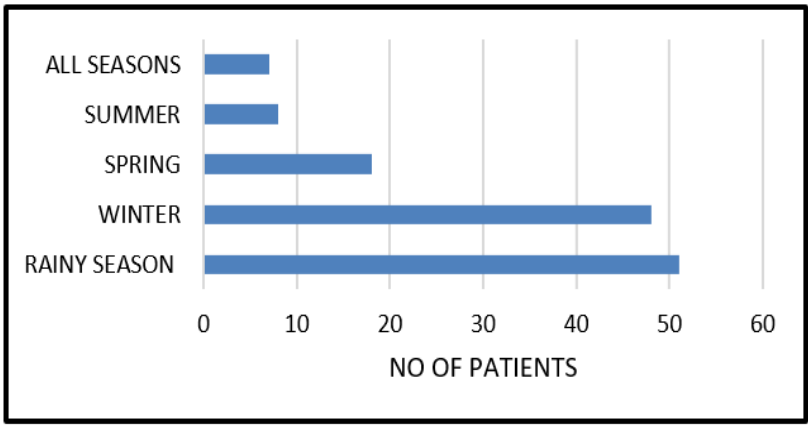

Figure 15: Crossed Bar Chart of Seasonal Variation (N=75)

Majority of cases showed seasonal variation with maximum exacerbations occurring during rainy (68%, n=51) and winter (64%, n=48) season. About 24% cases (n=18) showed exacerbation during spring, 10.7% cases (n=8) during summer and 9.3% cases (n=7) in all seasons in our study.

Table 13: Associated Factors (N=75).

Allergic Rhinitis	42 (56.0%)
Atopic Dermatitis	12(16%)
Urticaria	3(4%)
Family History of Asthma	41 (54.7%)
Family History of Allergic Rhinitis	6(8%)
Low Birth Weight	10(13.3%)

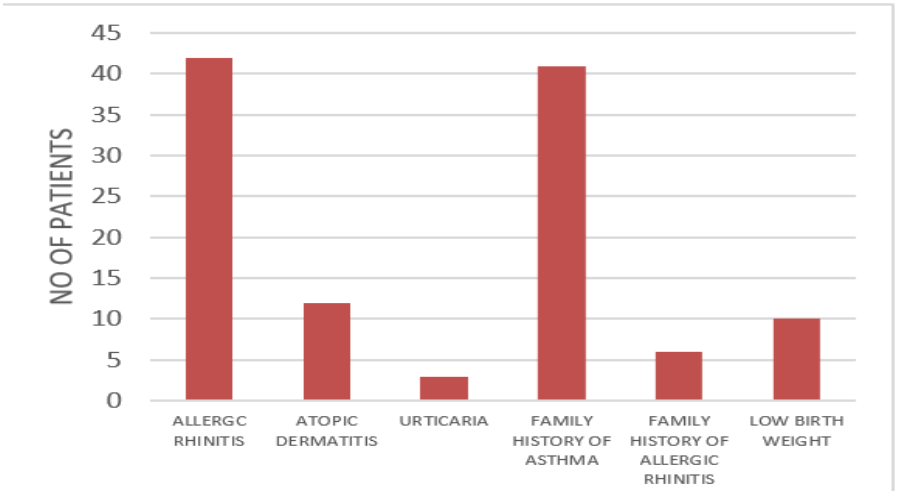

Figure 16: Bar Chart: Associated Factors (N=75)

Majority of cases are associated with allergic rhinitis (56.0%, n=42) and family history of asthma (54.7%, n=41). Atopic dermatitis was present in 16% (n=12) of cases, low birth weight in 13.3% (n=10) of cases, family history of allergic rhinitis in 8% (n=6) of cases and urticaria in 4% (n=3) of cases in this study.

Table 14: Type of Medication Used (N=75).

Mode Of Delivery	Medications Used	Number
Inhaler	Only Salbutamol	10(13.3%)
	Salmeterol/Fluticasone	18(24%)
	Formoterol/Budesonide	2(2.6%)
Nebulization	Only Salbutamol	15(20%)
	Salbutamol/Budesonide	14(18.6%)
Oral	Bronchodilator	12(16%)
	Steroid	4(5.3%)

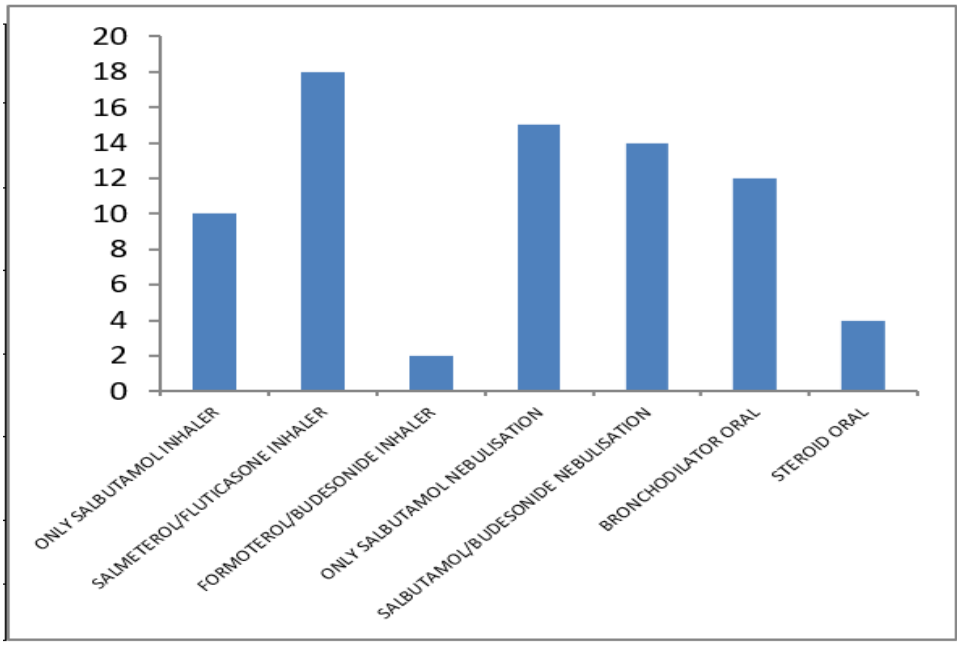

Figure 17: Bar Chart: Medications

In our study, 13.3% (n=10) cases used only salbutamol as inhaler, 24% (n=18) used combination of salmeterol and fluticasone, 2.6% (n=2) used formoterol and budesonide combination as inhaler, 18.6% (n=14) cases used salbutamol and budesonide nebulization during attacks. Only 16% (n=12) used oral bronchodilators.

Table 15: Predicted Improvement of PEFR in Percentage (N=75).

Improvement (% of predicted PEFR)	5 min (no of cases)	10 min (no of cases)	15 min (no of cases)
10-15	12(16%)	8(10.7%)	0(0.0%)
16-20	22(29.3%)	10(13.3%)	0(0.0%)
21-25	12 (16%)	17(22.6%)	3(4%)
≥26	29(38.6%)	40(53.4%)	72(96%)

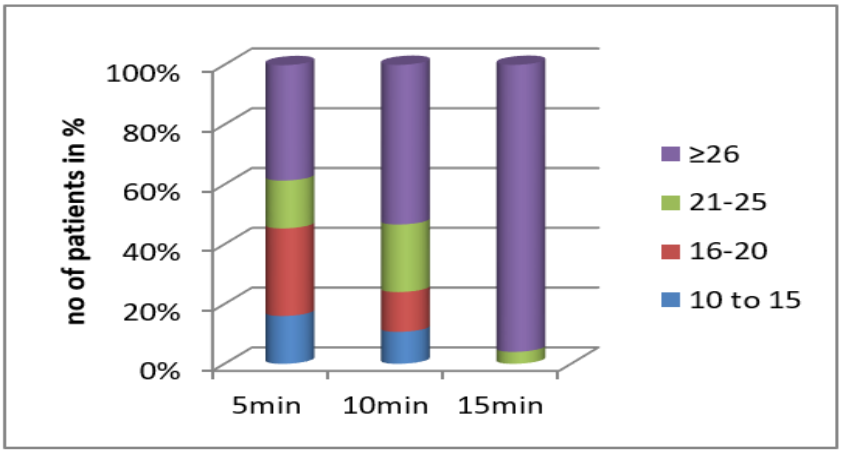

Figure 18: Composite Bar Chart of Predicted Improvement of Pefrin Percentage (N=75)

In our study, 96% of cases showed improvement in PEFR by ≥26 %, 4% of cases showed improvement in PEFR by 21% to 25% after 15 minutes of treatment. At 5 minutes, 16% cases showed improvement in PEFR by 10% to 15%, 29.3% cases showed improvement by 16% to 20% and 16% cases showed improvement by 21% to 25%. At 10 minutes, 10.7% cases showed improvement in PEFR by 10% to 15%, 13.3% cases showed improvement by 16% to 20% and 22.6% cases showed improvement by 21% to 25%.

Discussion

Study is hospital based cross sectional study, done at Pediatric department of Chettinad Institute of Medical Sciences from December 2019 to June2021. Present study includes 75 patientsof acute asthma exacerbations.

Among the study group, there was one female of 18 years and 3males of 17 years. Age group of 6-9 years constituted 46.8% of the cases and 48% of cases were of the age group of 10-15 years. Since only those who can blow PEFR were included in the study, children below 6 years were excluded and older children selected. So, the mean age group of presentation was 9.81±0.2 years.

Male children were 56% (n=42) and females 44 % (n=33) which was comparable to studies conducted in India [13,14]. The etiology of predominance of this disease is not known in male. But it would be due to the hormonal difference which has led to the gender-wise difference in the airway patency.

In our study, 40% of cases belongs to lower socio-economic status, 2.6% belonged to upper class, 12.2% belongs to upper middle class, 22.6% belongs to upper lower class, 20% belongs to lower upper class and 2.6% belongs to middle lower class.

Majority (66%) of asthma cases belonged to lower socioeconomic status as reported in Indian Journal of Paediatrics by Paramesh H 15. But in a study conducted in Pune city by Maria C et al. they have proved that asthma is more common in higher socioeconomic class according to hygiene hypothesis and excessive consumption of junk foods with lack of physical exercise [16].

In the last 12 months, many (40%) children missed 1-2 days of school, and 13.4% children missed school for more than 15 days, 60% of children had taken treatment in emergency department 1-2 times and only 17.4% were treated in emergency department more than 5 times. 45.3% of cases were hospitalized once in the last 12 months and 4.3% cases were hospitalized more than 5 times in one year. These data describe the severity of asthma of our study group.

Children with persistent asthma (57.4%) are more when compared to children with intermittent asthma (42.6%). This is explained by the increasing incidence of persistent asthma as reported by Paramesh H. [17,18]

Dust was the most common triggering factor-52%, followed by exercise (16%), chalk dust (13.3%), and food (13.3%) and smoke (5.4%). In a study in Lebanon, parents cited dust as the most common triggering factor for asthma. [19]

Majority of the cases showed seasonal variation as a cause for triggering asthma attacks in study done by H Paramesh [18]. Asthma exacerbations were more during rainy season (68%) and winter season as done by Han YY et al [20] (64%). Similar results were reported in a study conducted in rural India by Pradeepa P et.al [13]. Asthma didn't show any seasonal variation in 9.3% of cases. In Latin America study done by M.D.F.G. de Luna et al showed the prevalence of allergic rhinitis in asthmatic patients ranges from 28% to 95% whereas isolated allergic rhinitis is only upto 20% [21]. In our study, 56% of asthmatic children had allergic rhinitis, prevalence similar to that reported in Peruvian school children [22,23]. 16% children had atopic dermatitis which is explained by the study "on atopic March" done by T Zheng et al [24]. 54.7% of cases had family history of asthma [25,26,27]. Although asthma is known to run in families, and is associated with over 100 genes, the identification of asthma gene has become elusive.

Majority of children were well aware of inhaler (39.9%) and nebulizer (38.6%) therapy. 24% of children were taking long-acting beta agonist and steroid combination inhaler. 18.6% were taking salbutamol and budesonide nebulization during acute attacks. But this doesn't determine the educational status and awareness of parents as the study sample was very small.

In our study, by 5 minutes of nebulization majority (38.6%) cases showed improvement in PEFR by ≥26%, by 10 minutes 53.4% cases showed improvement by ≥26% and 22.6% cases showed improvement by 21-25% and by 15 minutes 100% cases showed improvement by more than 20%.In our study, first treatment for all cases were combination of salbutamol and budesonide nebulization and then treatment protocols according to severity was started.

The mPIS passed two formal validity tests in the present study (construct validity and criterion validity).

The extent to which mPIS estimates airway obstruction is the Construct validity. Pre- and post-treatment mPISs and PEFRs were properly correlated to establish construct validity. PEFR is the established procedure to calculate airway obstruction, and it is seen to improve with treatment. In this study it improved from mean predicted PEFR of 38.6% to 96% ($p = 0.001$). There is decrease in the degree of airway obstruction with good treatment which will further improve the PEFR.

The mPIS should show this change which is assessed by decrease in the score. With treatment there is reduction in mPIS from a mean of 5.56 to 1.31 ($p = 0.001$).

Criterion validity is the extent of correlation between the instrument & established criterion. Since the PEFR measures the asthma exacerbation severity it is used as established criterion. The PEFR and mPIS were both measured simultaneously. The pre-treatment and post-treatment mPIS and PEFR correlations are $r = -0.534$ and $r = -0.403(0.01)$ at 15 minutes respectively.

Even though PFT's gives accurate evaluation of airway obstruction still it needs staff training, result

interpretation and also the special equipment for conducting this test. Better compliance from children is must to obtain good measurements for both PEFRs and PFTs. So, the mPIS is easiest possible objective method to check the acute asthma exacerbation severity. The score includes accessory muscle use, wheeze, respiratory rate, heat rate, SPO2% and inspiratory/expiratory ratio. To obtain these 6 components in children, little extra staff training is necessary.

There was comparison between the signs of respiratory distress & measures of lung function using other clinical scoring systems and it correlated similarly with mPIS and PEFRs which ranged from -0.456 to -0.612. The correlations of FEV1 and CSS with O2 saturation were r = 0.52 and r = 0.49 respectively in study by Kerem E et al [28]. FEV1 (r = - 0.54) and Oxygen saturation (r = -0.45) are correlated with the Asthma Severity Score (ASS) in study done by Yung M et al [29]. These correlations seemed to be lower than expected. All of these scoring systems do not actually measure airway obstruction, and these are just based on physical signs. And hence there is limited correlation.

Even with treatment for many weeks, the underlying airway obstruction may not come to normal, even though clinically child improves with treatment. Hence it is difficult to compare the clinical scores and measures of airway obstruction. Similarly in present study also some subjects had mPISs showing slight severity however they had PEFRs lesser than expected and this could be explained with slow recovery of airway obstruction as described above. Objective clinical scoring systems have important part to play when true measures of airway obstruction are not easily obtainable for estimating the severity of obstruction in asthmatic children despite of their flaws.

Difficulty in performing PEFRs in subjects with increased respiratory distress is based on the fact that they cannot inhale completely before forceful exhalation. After bronchodilator therapy there was decrease in airway obstruction by which Child could undergo PEFRs easily. This is the reason why the mPIS & PEFR had better correlation after therapy with bronchodilators.

Summary:

To validate mPIS as a test to determine asthma severity and child's treatment response, a study was done in Department of Pediatrics- Chettinad hospital and research institute. The score included physical findings like wheeze, SPO2, respiratory rate, heart rate, inhalation-exhalation ratio and use of accessory muscle.

A total of 75 subjects between 6-18 years old with asthma exacerbations were randomly chosen ranging from mild to moderate disease. The mPIS and PEFR are measured at the same time before treatment and at 5 minutes, 10 minutes, and 15 minutes after treatment and during discharge. The recorded PEFR is represented as a percentage of normal PEFR. Normal PEFR calculated by referring to age, sex and height-based charts. Detailed history was taken, and anthropometric parameters were recorded according to the predesigned case proforma.

As airway obstruction improved with the bronchodilator therapy, PEFR increased and mPIS decreased significantly. Paired t-tests were used to compare pre-and post-treatment mPIS and PEFRs and to establish construct validity. Significant negative correlation was found between pre-treatment PEF Randm PIS and post-treatment PEFR and mPIS which validated the score through criterion validity. Findings of this study suggested that mPIS can be used as a tool to direct the therapy and to measure the asthma severity.

Conclusion

The mPIS is a handy method for evaluation of airway obstruction. The mPIS has higher post-treatment association for smaller airway obstruction than larger. As a result, mPIS makes it simple to determine mild severity and treatment response.

When spirometry is unavailable, another instrument to determine severity is necessary. In children mPIS appears to be easy scoring method for airway obstruction. The mPIS has been validated by construct validity & criterion validity. Construct validity of mPIS is by correlation between pre- and post-treatment values and criterion validity is from correlation between mPIS and PEFR. Hence when other methods such as PEFRs are not available to evaluate airway obstruction in children mPIS can be used and may also be used to guide therapy and to check response to given treatment.

Limitations:

1. Comparison done between the mPIS & PEFR, (alternate for spirometry).
2. Expiratory maneuvers are difficult to test in patients with extreme airway obstruction since the patient will struggle during air intake.
3. Younger subjects having difficulty to undergo PEFRs were not included.
4. More research into the use of the mPIS for younger age groups and those with more serious symptoms is necessary.

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