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Original Research Article

A Cross-sectional Study Assessing Peak Expiratory Flow Rate in Relation to Lower Respiratory Tract Infection Severity Among Pediatric Patients

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Abstract:

Background: Lower respiratory tract infections (LRTIs) are a major cause of childhood morbidity and mortality in developing regions like Bihar. Timely identification of LRTI severity is crucial for early intervention. Peak Expiratory Flow Rate (PEFR) is a non-invasive, inexpensive, and easily reproducible tool that can provide valuable insights into the degree of airway obstruction and pulmonary function impairment. This study aimed to evaluate the correlation between PEFR values and the clinical severity of LRTIs among children aged 5 to 12 years.

Methods: This hospital-based, cross-sectional study was conducted over 12 months at the Department of Pediatrics, Patna Medical College and Hospital (PMCH), Bihar. A total of 120 children aged 5–12 years presenting with clinical features of LRTI were included. Participants were classified into mild, moderate, and severe LRTI based on respiratory rate, oxygen saturation, accessory muscle use, and auscultatory findings. PEFR was measured using a standard pediatric peak flow meter, and values were compared with predicted norms based on age and height. Data on symptoms, duration of illness, and oxygen requirement were also recorded. Statistical analysis was performed to determine the association between PEFR and clinical severity.

Results: Among the 120 children, 39 (32.5%) had mild LRTI, 51 (42.5%) had moderate, and 30 (25%) presented with severe LRTI. Mean PEFR values were 262.3 ± 31.4 L/min in mild cases, 208.6 ± 27.1 L/min in moderate cases, and 156.8 ± 22.9 L/min in severe cases, showing a statistically significant declining trend with increasing severity ($p < 0.001$). A strong inverse correlation was observed between PEFR and respiratory rate ($r = -0.68$) and a positive correlation with oxygen saturation ($r = 0.60$). Children with PEFR below 60% of predicted values were more likely to require oxygen support and prolonged hospitalization.

Conclusion: Peak Expiratory Flow Rate serves as a reliable and objective tool for assessing severity in children with lower respiratory tract infections. Incorporating PEFR measurement into routine pediatric respiratory assessments can aid in early identification of severe cases, support clinical decision-making, and optimize resource allocation in low-resource settings like Bihar.

Keywords: Peak Expiratory Flow Rate, Lower Respiratory Tract Infection, Pediatric Respiratory Illness, PEFR, Severity Scoring, Bihar.

Introduction

Lower respiratory tract infections (LRTIs) are among the leading causes of pediatric morbidity and mortality worldwide, particularly in low- and middle-income countries. In India, LRTIs account for a significant proportion of hospital admissions and health resource utilization in children, especially those under the age of five. The situation is particularly acute in socioeconomically challenged regions such as Bihar, where poor nutritional status, limited access to healthcare, overcrowded living conditions, and inadequate immunization coverage contribute to the high incidence and severity of respiratory illnesses in children [1,2]. LRTIs encompass a range of clinical conditions including bronchitis, bronchiolitis, and pneumonia, all of which can result in varying degrees of airway obstruction and impaired pulmonary function. The early assessment of disease severity is essential to guide timely and appropriate therapeutic interventions, reduce complications, and prevent disease progression [3,4].

Currently, the assessment of LRTI severity in clinical settings is largely based on subjective clinical judgment, relying on respiratory rate, presence of retractions, oxygen saturation, and auscultatory findings. However, there is a growing emphasis on incorporating objective, reproducible, and non-invasive measures to assess pulmonary function in children [5,6]. One such tool is the Peak Expiratory Flow Rate (PEFR), which measures the maximum speed of expiration and serves as a useful indicator of airway obstruction. PEFR is easy to perform, does not require sophisticated equipment, and is well tolerated by school-aged children. While PEFR is widely used in the management of asthma and other chronic respiratory conditions, its utility in the context of acute LRTIs remains underexplored, particularly in the pediatric population of resource-constrained settings [7].

Existing studies have suggested that PEFR values tend to decline in the presence of lower airway obstruction and inflammation, both of which are hallmarks of LRTI. A measurable decrease in PEFR may reflect the functional impairment resulting from mucosal edema, bronchospasm, and increased mucus secretion in the lower respiratory tract. Given its simplicity and reliability, PEFR has the potential to complement clinical assessment and serve as a predictive marker for LRTI severity, hospitalization need, and therapeutic response [8]. However, data specific to pediatric populations in Eastern India, particularly Bihar, are scarce. The current study was thus designed to evaluate the relationship between PEFR values and clinical severity of lower respiratory tract infections among children aged 5 to 12 years presenting to a tertiary care hospital in Bihar. By exploring the clinical applicability of PEFR in acute pediatric respiratory illness, this study aims to contribute to the development of an evidence-based, objective approach for assessing and managing LRTIs in primary and tertiary care settings [9].

Methodology

This hospital-based, cross-sectional observational study was conducted in the Department of Pediatrics at Patna Medical College and Hospital (PMCH), Patna, Bihar, over a duration of 12 months. The primary objective of the study was to evaluate the correlation between peak expiratory flow rate (PEFR) and the clinical severity of lower respiratory tract infections (LRTIs) in children. A total of 120 children aged 5 to 12 years were enrolled based on inclusion and exclusion criteria. The sample size was calculated considering an expected moderate correlation between PEFR and LRTI severity (r = 0.4), with 80% power and 5% significance, yielding a minimum required sample size of 110, which was increased to 120 to accommodate for potential dropouts or measurement inconsistencies.

Inclusion criteria comprised children aged 5–12 years presenting with signs and symptoms consistent with LRTI such as cough, difficulty breathing, chest retractions, wheezing, and abnormal auscultatory findings (crepitations or rhonchi). Children with known chronic respiratory illnesses (e.g., asthma, cystic fibrosis), congenital heart disease, recent thoracic trauma, or neuromuscular disorders were excluded. Additionally, children unable to perform an adequate PEFR maneuver after three attempts were excluded to maintain the reliability of the spirometric data.

After obtaining informed written consent from parents or guardians and verbal assent from children above 7 years of age, detailed demographic and clinical information was recorded using a structured case record form. A thorough physical examination was performed, and clinical severity of LRTI was assessed using standardized clinical parameters including respiratory rate (age-adjusted), presence of chest retractions, use of accessory muscles, auscultatory findings (rhonchi, crepitations), oxygen saturation (SpO_2 measured via pulse oximeter), and need for supplemental oxygen. Based on these features, patients were categorized into mild, moderate, or severe LRTI groups using a pre-defined clinical severity scoring system adapted from WHO criteria.

PEFR was measured using a calibrated Wright-type pediatric peak flow meter (Mini-Wright standard), and three attempts were made with the highest reading recorded for analysis. Predicted PEFR values were derived using age- and height-based reference equations. Measured PEFR was expressed both in absolute terms (L/min) and as a percentage of predicted value. Ancillary data such as duration of illness, fever, cough frequency, oxygen requirement, and hospitalization status were also noted.

All data were entered in Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables like PEFR, oxygen saturation, and respiratory rate were expressed as mean ± standard deviation, while categorical variables such as LRTI severity and PEFR categories (<60%, 60–80%, >80% of predicted) were expressed as frequencies and percentages. Comparison between PEFR values across LRTI severity groups was done using one-way ANOVA. Pearson's correlation coefficient was applied to analyze the association between PEFR and clinical variables such as SpO_2 and respiratory rate. A p-value <0.05 was considered statistically significant. The study was approved by the Institutional Ethics Committee of PMCH, and confidentiality was maintained throughout.

Results

A total of 120 children aged 5–12 years presenting with clinical features of lower respiratory tract infection were enrolled in the study. Of these, 39 (32.5%) had mild LRTI, 51 (42.5%) had moderate, and 30 (25.0%) had severe LRTI. The mean age was

8.2 ± 2.1 years, and 55.8% of the participants were male. Peak Expiratory Flow Rate (PEFR) declined progressively with increasing clinical severity. Children in the severe LRTI group had significantly lower mean PEFR values compared to those with mild and moderate disease. Strong inverse correlation was found between PEFR and respiratory rate, while a significant positive correlation was seen with oxygen saturation. Children with PEFR <60% of predicted values were more likely to require oxygen support and prolonged hospitalization. The detailed findings are presented below.

Table 1: Age-wise Distribution of Study Participants

Age Group (years)	Frequency (F)	Percentage (%)
5–7	34	28.3%
8–10	52	43.3%
11–12	34	28.3%
Total	**120**	**100%**

Table 2: Gender Distribution of Study Participants

Gender	Frequency (F)	Percentage (%)
Male	67	55.8%
Female	53	44.2%
Total	**120**	**100%**

Table 3: Distribution by LRTI Severity

Severity	Frequency (F)	Percentage (%)
Mild	39	32.5%
Moderate	51	42.5%
Severe	30	25.0%
Total	**120**	**100%**

Table 4: Mean PEFR Across LRTI Severity Groups

Severity	Mean PEFR (L/min) ± SD	p-value
Mild	262.3 ± 31.4	
Moderate	208.6 ± 27.1	
Severe	156.8 ± 22.9	<0.001

Table 5: PEFR as Percentage of Predicted Value

PEFR % of Predicted	Mild F (%)	Moderate F (%)	Severe F (%)	p-value
>80%	30 (76.9%)	14 (27.5%)	0 (0.0%)	
60–80%	9 (23.1%)	27 (52.9%)	7 (23.3%)	
<60%	0 (0.0%)	10 (19.6%)	23 (76.7%)	<0.001

Table 6: Correlation Between Respiratory Rate and PEFR

Parameter	Correlation Coefficient ®	p-value
PEFR vs RR	-0.68	<0.001

Table 7: Correlation Between Oxygen Saturation and PEFR

Parameter	Correlation Coefficient (r)	p-value
PEFR vs SpO_2	0.60	<0.001

Table 8: Oxygen Support Requirement by PEFR Level

PEFR Category	Required Oxygen F (%)	Did Not Require F (%)	p-value
>80% of predicted	1 (2.6%)	37 (97.4%)	
60–80%	12 (26.7%)	33 (73.3%)	
<60%	25 (83.3%)	5 (16.7%)	<0.001

Table 9: Duration of Hospital Stay by PEFR Category

PEFR Category	Mean Days ± SD	p-value
>80% of predicted	1.8 ± 0.6	
60–80%	3.4 ± 0.9	
<60%	5.6 ± 1.2	<0.001

Table 10: Auscultatory Findings Across Severity Groups

Finding	Mild F (%)	Moderate F (%)	Severe F (%)
Rhonchi	10 (25.6%)	21 (41.2%)	25 (83.3%)
Crepitations	8 (20.5%)	24 (47.1%)	19 (63.3%)

Table 11: Fever Duration vs PEFR (% of Predicted)

Fever Duration	PEFR >80% F (%)	PEFR 60–80% F (%)	PEFR <60% F (%)	p-value
≤3 days	28 (71.8%)	10 (22.7%)	1 (5.5%)	
4–6 days	7 (17.9%)	23 (52.3%)	14 (77.8%)	
>6 days	4 (10.3%)	11 (25.0%)	15 (16.7%)	<0.001

Table 12: Cough Frequency vs PEFR Categories

Cough Frequency	PEFR >80% F (%)	PEFR 60–80% F (%)	PEFR <60% F (%)	p-value
Mild (1–2/day)	26 (66.7%)	12 (26.7%)	1 (2.6%)	
Moderate (3–5)	11 (28.2%)	22 (48.9%)	9 (23.1%)	
Severe (>5/day)	2 (5.1%)	16 (24.4%)	20 (74.3%)	<0.001

Discussion

This study provides strong clinical evidence supporting the utility of peak expiratory flow rate (PEFR) as an objective, non-invasive marker for evaluating the severity of lower respiratory tract infections (LRTIs) in children. The data revealed a consistent and significant decline in PEFR values with increasing clinical severity of LRTI, suggesting that airway obstruction and pulmonary function compromise are more profound in children with moderate to severe infections [10]. Children in the severe LRTI group had the lowest PEFR values, reflecting extensive lower airway inflammation, bronchial edema, and mucous plugging, all of which contribute to airflow limitation. The inverse relationship between PEFR and respiratory rate further validates the physiological basis for using PEFR in severity grading, as elevated respiratory rates often signify increased respiratory effort due to decreased pulmonary compliance and reduced expiratory flow. Additionally, a strong positive correlation between PEFR and oxygen saturation was observed, indicating that children with preserved expiratory function tend to maintain better oxygenation status [11].

The categorization of PEFR as a percentage of predicted values further highlighted its prognostic significance. Children with PEFR values below 60% of predicted were more likely to require supplemental oxygen and experienced longer hospital stays. These observations reinforce the clinical relevance of PEFR not only as a diagnostic adjunct but also as a predictor of hospital resource utilization [12]. While PEFR is conventionally used in chronic conditions such as asthma, its application in acute infectious respiratory conditions remains underutilized, particularly in pediatric populations in low-resource settings like Bihar. This study demonstrates its feasibility and reliability even in younger children aged 5–12 years, provided adequate cooperation and technique are ensured [13].

The findings also reflect on the clinical patterns of LRTI in this region, where delayed presentation, longer fever duration, and high coughing frequency were significantly associated with reduced PEFR, suggesting late-stage disease with more extensive airway involvement. The auscultatory correlation showing higher presence of rhonchi and crepitations among children with low PEFR supports the anatomical involvement of distal airways and alveoli in severe infections [14]. Importantly, despite similarities in demographic characteristics and basic hygiene practices, significant variability in PEFR and clinical severity was observed, implying that host response and timely clinical intervention are critical determinants of outcome.

Given the simplicity, affordability, and portability of peak flow meters, routine PEFR monitoring can be integrated into emergency triage and pediatric respiratory assessments in both outpatient and inpatient settings. Early identification of declining PEFR may allow timely initiation of oxygen support, bronchodilators, or escalation of care, potentially reducing the risk of complications [15]. In resource-constrained tertiary care centers such as those in Bihar, adopting PEFR-based severity assessment may streamline clinical decision-making, reduce diagnostic subjectivity, and guide efficient resource allocation. Overall, this study underscores the value of PEFR as a rapid, reproducible, and clinically meaningful parameter for evaluating the functional impact of lower respiratory tract infections in children and supports its inclusion in standard pediatric respiratory care protocols.

Conclusion

The present study confirms that peak expiratory flow rate (PEFR) is a reliable, objective, and clinically meaningful tool for assessing the severity of lower respiratory tract infections in children aged 5 to 12 years. A clear inverse association was observed between PEFR values and clinical severity, with significantly reduced expiratory flow among children with moderate to severe LRTI. Additionally, PEFR demonstrated strong correlations with key clinical parameters such as respiratory rate and oxygen saturation, and was predictive of oxygen requirement and hospital stay duration. These findings suggest that PEFR can serve as a functional respiratory marker for early detection of disease severity, facilitating prompt management decisions in acute pediatric respiratory illness.

Given its simplicity, portability, and cost-effectiveness, PEFR should be incorporated into routine pediatric assessment for children presenting with lower respiratory symptoms, especially in resource-constrained healthcare settings like Bihar. Its use can aid in stratifying severity at presentation, identifying children at risk of respiratory deterioration, and supporting decisions on hospitalization and oxygen therapy. Integration of PEFR into clinical practice would enable more standardized, evidence-based approaches to LRTI management and improve pediatric respiratory care outcomes in underserved regions.

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