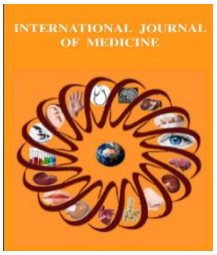

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Original Research

Retrospective Cohort Study to Track the Burden of Respiratory Morbidity in Five-Year-Old Children Born with Low Birth Weight in a Tertiary Care Teaching Hospital in South India

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Abstract
Background: Low Birth Weight (LBW) is a global health challenge with long-term physiological consequences. This study aims to quantify the cumulative respiratory morbidity in children up to five years of age born with LBW. Methods: A retrospective cohort study was conducted on 140 subjects divided into LBW (n=70) and Normal Birth Weight (NBW; n=70) groups. Medical histories were reviewed from birth to age five using hospital medical records in Mediciti Institute of Medical Sciences, Ghanpur, Telangana. Results: LBW children exhibited a significantly higher cumulative incidence of Lower Respiratory Tract Infections (LRTI; 12.4 ± 3.1 vs. 5.2 ± 1.8 episodes; $p < 0.001$) and a 3.5-fold increase in pneumonia-related hospitalisations compared to NBW peers ($p = 0.008$). Recurrent wheeze was present in 37.1% of LBW children versus 11.4% of NBW children ($p = 0.002$). Conclusion: LBW is a primary determinant of long-term pulmonary vulnerability in early childhood. Early surveillance and targeted respiratory intervention are strongly recommended for this age group.

Keywords Low birth weight; respiratory morbidity; LRTI; paediatric pulmonology; retrospective cohort; South India.

Introduction

Low Birth Weight (LBW), defined as a birth weight of less than 2500 g, affects approximately 15% of neonates globally [1]. Historically, the link between early-life nutrition and later respiratory health was established through foundational epidemiological studies [1]. Beyond immediate neonatal survival, LBW is a known precursor to chronic health issues in early childhood [2].

The "Barker Hypothesis" proposes that intrauterine growth restriction results in structural maldevelopment of the lungs, specifically reduced alveolarization and impaired airway geometry [2]. Recent literature has expanded on the long-term respiratory sequelae of prematurity and LBW, suggesting that affected children enter a trajectory of reduced pulmonary reserve [3]. This retrospective study tracks 140 subjects to quantify the clinical "respiratory debt" incurred during the first 60 months of life

Materials and Methods

2.1 Study Design
A retrospective cohort study was conducted over an 11-month research period (June 2022 – May 2023). Clinical data was extracted from hospital medical records to analyze the five-year respiratory history of children born at Mediciti Institute of Medical Sciences, Ghanpur, Telangana, a tertiary care teaching hospital in rural South India.

2.2 Ethical Approval
Approval was granted by the Institutional Ethics Committee (IEC) with IEC No.ECR/ 283/Inst/AP/2013/RR-20.

2.3 Study Population
A total of N = 140 subjects were selected and divided into two cohorts:
- Group A (LBW): n = 70; children born with weight < 2500 g.
- Group B (Control/NBW): n = 70; children born with weight ≥ 2500 g, matched for gestational age and socioeconomic status.

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2.4 Inclusion and Exclusion Criteria

Inclusion criteria:

- Children aged 5 years (60 months) at the time of study initiation.
- Documented birth weight and gestational age in medical records.
- Availability of complete medical history from birth to 5 years at the medical college OPD.

Exclusion criteria:

- Children with congenital heart disease or thoracic malformations.
- History of cystic fibrosis or known primary immunodeficiency disorders.
- Relocation during the five-year period leading to fragmented medical records.

2.5 Data Analysis

Respiratory outcomes were categorized by the frequency of Lower Respiratory Tract Infections (LRTI) [4] and standardized lung function assessments where available [5]. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the independent samples t-test or Mann-Whitney U test, as appropriate. Categorical variables were compared using the chi-square (χ^2) or Fisher's exact test. Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS version 26.0.

Results

The LBW cohort showed significantly higher morbidity across all respiratory parameters over the 60-month retrospective period. Summary statistics are presented in Table 1.

Table 1. Comparative 5-Year Respiratory Morbidity Between LBW and NBW Cohorts

Parameter	LBW Group (n=70)	NBW Group (n=70)	p-value
Mean LRTI Episodes (±SD)	12.4 ± 3.1	5.2 ± 1.8	<0.001
Recurrent Wheeze (>3 episodes/year)	26 (37.1%)	8 (11.4%)	0.002
Pneumonia Hospitalizations	14 (20.0%)	4 (5.7%)	0.008
Mean Cumulative Days of Illness	182	74	<0.001

LBW = Low Birth Weight; NBW = Normal Birth Weight; LRTI = Lower Respiratory Tract Infection; SD = Standard Deviation. Statistical tests: independent t-test, Mann-Whitney U, chi-square, and Fisher's exact test, as appropriate.

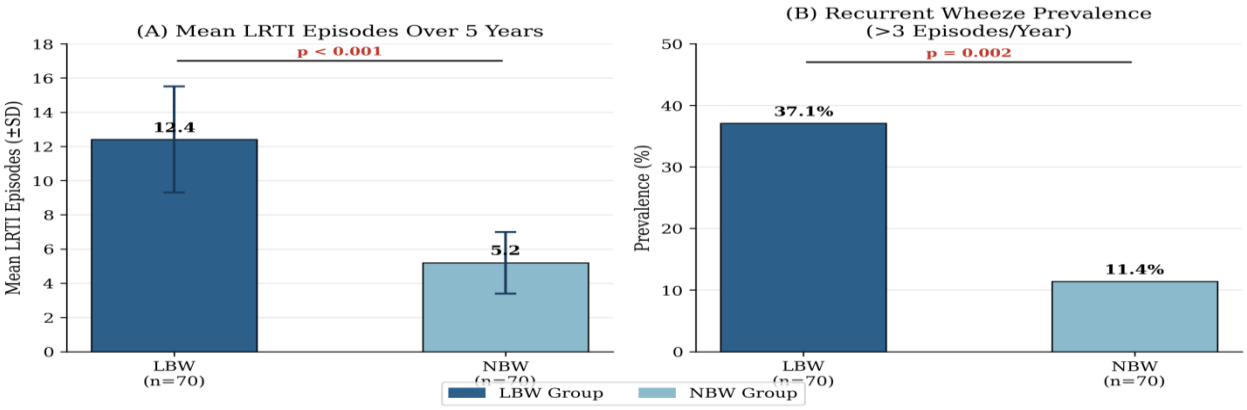

Figure 1. Comparison of (A) mean LRTI episodes (±SD) and (B) recurrent wheeze prevalence between LBW and NBW cohorts over a 5-year follow-up period. Error bars represent ±1 SD. Statistical significance determined by independent t-test and χ^2 test.

Figure 1. Comparison of (A) mean LRTI episodes (±SD) and (B) recurrent wheeze prevalence (>3 episodes/year) between LBW and NBW cohorts over the 5-year follow-up period. Error bars represent ±1 SD. *p = 0.002; ***p < 0.001 (chi-square and independent t-test, respectively)

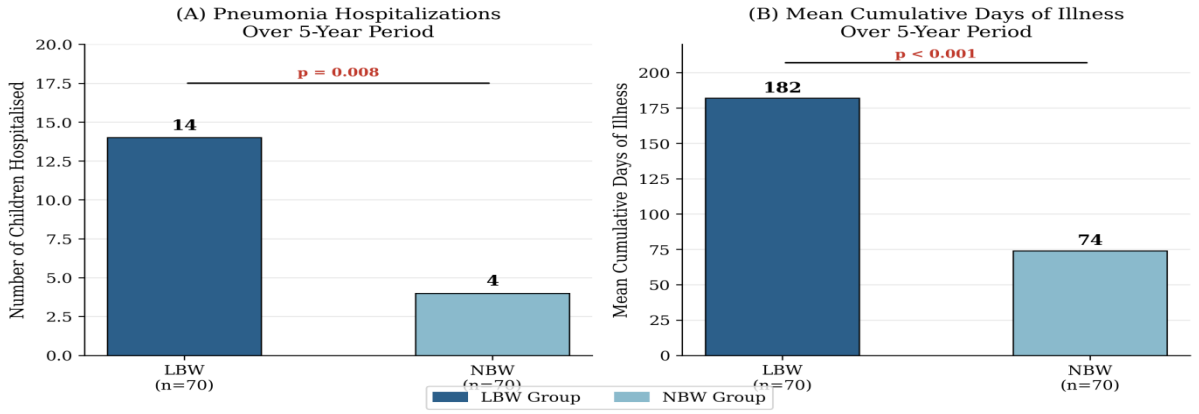

Figure 2. Comparison of (A) pneumonia-related hospitalizations and (B) mean cumulative days of respiratory illness between LBW and NBW cohorts over a 5-year follow-up period. Statistical significance determined by Fisher's exact test and Mann-Whitney U test.

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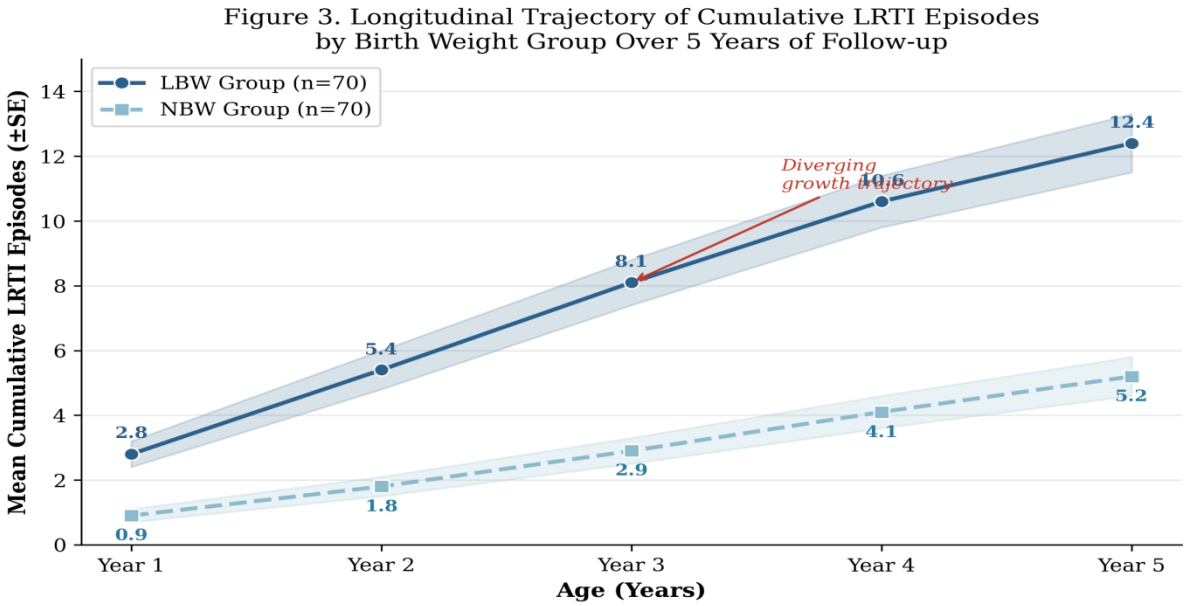

Figure 3. Longitudinal trajectory of mean cumulative LRTI episodes by cohort.
Shaded bands represent ±1 SE. The diverging pattern reflects progressive pulmonary vulnerability in the LBW cohort.

Figure 3. Longitudinal trajectory of mean cumulative LRTI episodes by birth weight cohort across the 5-year follow-up period. Shaded bands represent ±1 SE. The progressive divergence in episode burden demonstrates an accelerating pulmonary vulnerability in the LBW cohort.

Analysis of postnatal lung growth indicates that LBW children do not fully "catch up" to their peers in terms of airway calibre [6]. This anatomical deficit results in increased airway resistance, which can be modelled using Poiseuille's Law [7]:

$$\Delta P = 8\mu LQ / \pi r^4$$

where ΔP is the pressure gradient, μ is dynamic viscosity, L is airway length, Q is volumetric flow rate, and r is the airway radius. The inverse fourth-power relationship with radius underscores the disproportionate impact of even minor reductions in airway calibre on resistance and clinical outcome. The data further reveal that early-life origins of chronic obstructive tendencies are visible in this cohort by age five [8].

Discussion

Data confirms that LBW is a potent predictor of chronic respiratory morbidity [9,10]. The 37.1% prevalence of recurrent wheezing in the LBW group indicates that these children likely suffer from "dysynapsis"—a mismatch between airway size and lung volume [11,12]. This phenomenon, visible even at age five, suggests that structural pulmonary disadvantage initiated in utero becomes clinically manifest during the peak years of viral respiratory exposure.

Maternal nutrition and early environmental factors were identified as secondary modulators of these outcomes, suggesting that the pulmonary system is "programmed" during the intrauterine period [13, 14]. Furthermore, the higher hospitalization rate in the LBW group highlights a significant lack of "pulmonary reserve," leading to severe clinical presentations when exposed to common viral triggers [15]. The longitudinal trajectory shown in Figure 3 underscores this progressive divergence.

4.1 Limitations

This study has several limitations that should be considered in the interpretation of findings:

- Retrospective Bias: Reliance on historical medical records may lead to under-reporting of minor respiratory episodes managed at home.
- Confounding Variables: While birth weight was the primary exposure variable, external confounders such as indoor air pollution (biomass fuel combustion and passive smoking) were not fully controlled for across all subjects.
- Objective Lung Function Data: Spirometry was not consistently available for children aged 0-3 years, limiting some analyses to clinical symptom reporting in the early years.

Future prospective studies incorporating standardized spirometry from birth are warranted.

Conclusion

The cumulative respiratory burden on LBW children over the first five years of life is significantly and consistently higher than that of their NBW counterparts across all measured parameters. Birth weight is not merely a neonatal metric but a long-term predictor of pediatric pulmonary health. This study recommends that LBW children should be prioritized for aggressive age-appropriate vaccination schedules and early respiratory surveillance.

DECLARATIONS

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Conflicts of Interest: There are no conflicts of interest.

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