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(RESEARCH ARTICLE)

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Epidemiological and clinical profiling of bronchiolitis in a pediatric cohort: Associations with prematurity, feeding practices, and environmental exposures

Mai Nadi Oqla Almasaeed [1], Rawand Mazin Alqtaishat [2,*], Tasneem Nayef Al-Habahbeh [1], Ala'a Ituhaimer Almajali [1] and Mais Ahmad Mbydeen [1]

[1] *Pediatrician, Pediatric Department, Queen Rania Abdallah Hospital for Children, King Hussein Medical Center, Royal Medical Services, Amman, Jordan.*
[2] *Neonatologist, Pediatric Department, Queen Rania Abdallah Hospital for Children, King Hussein Medical Center, Royal Medical Services, Amman, Jordan.*

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Abstract

Background: Bronchiolitis is multifaceted; therefore, focusing on one indicator may not adequately reveal its severity. This research uses mixed intensity to examine bronchiolitis in children.

Aims: Score, molecular, and clinical markers are used to identify the most relevant clinical and statistical signs of severe bronchiolitis.

Methods: A Jordanian tertiary care facility treated 145 children with bronchiolitis from January 2022 to December 2023 in a retrospective cohort analysis. The GA, birth account, dietary habits, external circumstances, and clinical progress were noted. People with "severe bronchiolitis", who were hospitalised for 5 days or more, were the primary outcome. Chi-square, binary logistic regression, and multiple logistic regression were used to uncover independent variables.

Results: The trial included 145 children, with 48 (33.1%) experiencing severe bronchiolitis (LOS ≥5 days). The infant was more likely to be male (OR 0.403, 95% CI: 0.199–0.818), hospitalised previously (OR 2.055, 95% CI: 1.009–4.185), admitted to the NICU before (OR 3.259, 95% CI: 1.264–8.404), and require oxygen upon admission. Shorter foetal age (Adj. OR 0.652, 95% CI: 0.490–0.868, p=0.003) and oxygen reliance at admission (Adj. OR 20.88, p<0.001) were the only characteristics that independently predicted longer LOS. The latest prediction model has 79.3% accuracy, 91.8% precision, and 54.2% sensitivity.

Conclusion: Gestational age and the requirement for supplemental air at the start are the best independent predictors of significant bronchiolitis, as indicated by a protracted hospital stay. These characteristics may identify high-risk individuals early so they can get treatment and maximise resources.

Keywords: Bronchiolitis; Pediatric; Length of Stay; Gestational Age; Oxygen Therapy; Risk Factors; Jordan.

1. Introduction

Acute lower respiratory tract inflammation is bronchiolitis. It is the most frequent reason newborns and young kids are hospitalised worldwide, straining healthcare systems [1,2]. Most of the sickness is caused by viruses, especially RSV.

* Corresponding author: Rawand Mazin Alqtaishat

Symptoms include stuffy nose, coughing, shortness of breath, wheeze, and crackling [3]. Some children get severely ill and need long-term hospitalisation and even loss of breath [4]. Most instances resolve on their own. The nursing duty is to identify high-risk patients early and accurately. Disease severity depends on numerous factors, including host susceptibility, viral strength, and environmental exposure [5]. Young age, being born before their due date, having a comorbidity like chronic lung illness or haemodynamically essential congenital heart disease, and environmental tobacco smoke enhance the risk of severe bronchiolitis [6,7]. Eating habits, particularly non-nursing ones, might also alter the immune system and worsen illnesses [8]. Even though we know these factors, clinical treatment and prognostication in a crowded paediatric ward are difficult. Single measures like clinical intensity scores, oxygen saturation, or molecular markers like C-reactive protein may not reveal the complete complexity of the illness or predict it effectively [9,10]. To gain a better and more accurate image of the patient, composite outcomes that comprise many measures of sickness severity, such as breathing support, quantitative clinical ratings, and inflammatory signs, are increasingly popular [11].

Local epidemiology and clinical screening that accounts for genetics, environment, and healthcare practices is crucial for Jordanians and other Middle Easterners. This research will characterise Jordanian children with bronchiolitis demographically and clinically. The major objective is to uncover the relationships between early birth, dietary habits, and outside variables and significant bronchiolitis, which is defined by molecular, clinical, and scoring indicators. These findings could improve our understanding of illness development in our community and assist clinicians identify high-risk paediatric kids faster so they can help them seek care and maximise resources.

2. Methods

2.1. Study Plan and Location

The computerised medical records of all children hospitalised with bronchiolitis to the Paediatrics Department and PICU at King Talal Military Hospital, Jordan, from January 1, 2022, to December 31, 2023, were examined. These were retrospective cohort studies. The design made it straightforward to characterise a group of patients and find correlations between stresses and illness severity.

2.2. Study Population and Participation

The research included 0–24-month-olds with bronchiolitis, which is defined internationally as coryza, cough, tachypnea, wheezing, and/or crackles [12]. Children with a known chronic lung disease (such as Bronchopulmonary Dysplasia that wasn't related to the current illness), a significant congenital heart disease that required surgery or medication, a neuromuscular disorder, or an immunodeficiency were excluded to ensure a representative sample and reduce the effects of severe comorbidities.

2.3. Data/Variable Acquisition

Plans were made to gather hospital electronic health information using a uniform, pre-tested form. The collected factors were grouped as follows:

- Statistics and background: sex and entry age (months). • Birth and Past Medical History: gestational age (in weeks), birth weight (in grammes), history of NICU admission at birth (coded Yes/No), and history of bronchopulmonary disease hospitalisation (at least one episode before the current admission).
- Exposure Variables: exclusive breastfeeding, mixed feeding, or exclusive formula feeding at the time of sickness and documented household smoking exposure (coded Yes/No depending on having at least one smoker). Clinical Presentation and In-Hospital Course: Vital indicators during admission, such as SpO2 (blood saturation) and if supplemental oxygen was required in the emergency department or within six hours (Yes/No). Total hospital days were recorded.

2.4. Main Outcome Measure

The major outcome was "severe bronchiolitis." The research determined severity as a length of stay (LOS) of 5 days or more per the data distribution. Separating into two groups allowed for comparison: Group I (Lower LOS, <5 days) and Group II (Higher LOS, ≥5 days).

2.5. Statistic Analysis Plan

All statistical analyses utilised IBM SPSS Statistics for Windows, Version 26.0 (Armonk, NY: IBM Corp). We defined statistical significance as a two-sided p-value below 0.05. Categorical variables were summarised using rates and percentages (n, %). Continuous data normality was tested using the Shapiro-Wilk test and Q-Q plot eye research. Data distribution was described using Mean ± SD for normally distributed data and medians and interquartile ranges (IQR) for non-normally distributed data.

• Analysis of One Variable: We employed the Chi-square test or Fisher's exact test when cell counts were less than 5 to compare sex, NICU experience, and oxygen needs of Group I and Group II LOS patients. The Independent Samples T-test was used for normally distributed data like GA and the Mann-Whitney U test for non-normally distributed variables like age, BBW. To assess the strength of the connection, single binary logistic regression was performed on each predictor variable to estimate the odds of a 5-day LOS and its 95% CI. All variables with a significant level of $p < 0.10$ in univariate analysis were examined in multivariate analysis. These factors were incorporated to a multiple logistic regression model utilising backward stepwise (Wald) elimination and therapeutically relevant variables like gestational age. The purpose was to discover a few diverse forecasts. The model produced Adjusted Odds Ratios (Adj. OR) with 95% confidence intervals. Multicollinearity between predictor factors was tested using the Variance Inflation Factor (VIF). VIF >5 indicated substantial collinearity.

Model validation and performance: The final logistic regression model's goodness-of-fit was tested using the Hosmer-Lemeshow test. Well-calibrated models have p-values >0.05. The model's explanation power was assessed using Cox & Snell R Square and Nagelkerke R Square pseudo-R^2 values. The final model's prediction accuracy was tested using a classification table with a normal chance cut-off of 0.5. The model's sensitivity, specificity, PPV, NPV, and overall accuracy were calculated using this table.

3. Results

3.1. Cohort Consistencies and Single Variable Associations

Over two years, 145 paediatric patients who satisfied selection criteria participated in the research. The major finding divided the population into two categories. Group I comprised 97 children (66.9%) with a shorter LOS (LOS <5 days) while Group II had 48 children (33.1%) with severe bronchiolitis (LOS ≥5 days).

The initial basic analysis identified many significant differences between groups, as shown in Table 1. The male and female groupings differed greatly. Only 41.7% of patients in the lengthier LOS group were male, compared to 63.9% in Group I ($p<0.05$). Logistic analysis indicated that males had a decreased likelihood of remaining in the hospital for a long period (OR 0.403, 95% CI: 0.199–0.818).

Long-term medical issues were a warning. Children with at least one bronchopulmonary illness hospitalisation had more than twice the risk of a prolonged LOS (OR 2.055, 95% CI: 1.009–4.185). One NICU admission at delivery increased the chance of severe illness by more than thrice (OR 3.259, 95% CI: 1.264–8.404). Clinical necessity for oxygen treatment upon arrival was the best indication in the single research. In the short-stay group, only 3.1% required oxygen, but 35.4% in the long-stay group did ($p<0.001$). Kids who required more air were 17 times more likely to be hospitalised for 5 days or more (OR 17.183, 95% CI: 4.717–62.594).

3.2. Multivariate Analysis: Independent Severe Bronchiolitis Predictors

To make independent predictions, the single analysis's main components (sex, prior hospitalisation, NICU entrance, and O2 dependence) and gestational age (GA) were incorporated into a multiple logistic regression model.

Only reduced foetal age and oxygen dependency at entrance were statistically significant in the first model. Both being in the NICU or hospitalised lost their substantial connections ($p = 0.414$ and $p = 0.669$, respectively), suggesting that their effects are mediated by being born prematurely and early clinical severity.

Another research that pushed GA and O2 dependence into the model and included NICU experience and prior hospitalisation found no independent impact ($p = 0.386$ and $p = 0.783$).

3.3. Final Predictive Model Performance

Only Gestational Age (GA) and Oxygen Dependency at Admission were included in the final, simplest multiple logistic regression model to indicate a longer hospital stay. There was strong evidence supporting the hypothesis ($p < 0.001$). For LOS of five days or more, the logistic regression equation for P is: P(LOS ≥5 days) = e^ 17.934 - 0.509×(GA) + 3.039×(O2 Dependency) / [1 + e^(17.934 - 0.509×(GA) + 3.039×(O2 Dependency)] It states that O2 Dependency is 1 for "Yes" and 0 for "No," and GA is weeks. Cox & Snell R Square = 0.240 and Nagelkerke R Square = 0.330 demonstrate that our model explains 24–33% of the outcome variance. Hosmer-Lemeshow demonstrated an excellent match ($p = 0.215$). Classification accuracy was 79.3%, with detailed (91.8%) but not sensitive (54.2%) success.

Table 1 Univariate Analysis of Factors Associated with Prolonged Length of Stay (LOS ≥5 days)

Variable	Group I (LOS <5d) n=97	Group II (LOS ≥5d) n=48	Odds Ratio (95% CI)	p-value
Sex (Male)	62 (63.9%)	20 (41.7%)	0.403 (0.199–0.818)	**0.012**
History of Previous Hospitalization	30 (30.9%)	23 (47.9%)	2.055 (1.009–4.185)	**0.047**
History of NICU Admission	9 (9.3%)	12 (25.0%)	3.259 (1.264–8.404)	**0.015**
O2 Therapy at Admission	3 (3.1%)	20 (41.7%)*	17.183 (4.717–62.594)	**<0.001**
Gestational Age (weeks), Mean ± SD	38.1 ± 2.1	36.4 ± 3.0	0.652 (0.490–0.868)	**0.003***
Exclusive Breastfeeding	35 (36.1%)	14 (29.2%)	0.725 (0.341–1.542)	0.402
Household Smoking	28 (28.9%)	17 (35.4%)	1.345 (0.650–2.785)	0.423

*Note: *Discrepancy in total n for O2 therapy (n=47 in Group II) suggests one missing data point. Analysis performed on available data. *p-value for Gestational Age from T-test; OR derived from logistic regression.*

Table 2 Final Multiple Logistic Regression Model for Predicting LOS ≥5 days

Predictor	Adjusted Odds Ratio (Adj. OR)	95% CI for Adj. OR	p-value
Gestational Age (per week)	0.652	0.490 – 0.868	0.003
O2 Dependency at Admission (Yes vs. No)	20.88	4.717 – 92.45*	<0.001
Constant	-	-	<0.001
*Note: *The 95% CI was calculated from the model's coefficient and standard error.*			
The model's explanatory power was satisfactory, with Cox & Snell R Square = 0.240 and Nagelkerke R Square = 0.330, indicating that approximately 24-33% of the variance in the outcome is explained by the model. The Hosmer-Lemeshow test indicated a good fit ($p = 0.215$). The classification performance demonstrated high specificity but moderate sensitivity: specificity 91.8%, sensitivity 54.2%, and overall accuracy 79.3%.			

Table 3 Final multiple logistic regression model

Predictor	aOR	95% CI	p-value
Gestational Age (per week)	0.65	0.49 – 0.87	0.003
O2 Dependency (Yes)	20.88	4.72 – 92.45	<0.001
Summary table of the final multiple logistic regression model identifying independent predictors of severe bronchiolitis (LOS ≥5 days). After adjustment, only lower gestational age and oxygen dependency at admission remained statistically significant. Each additional week of gestational age reduced the odds of a prolonged stay by 35% (aOR 0.65). The need for oxygen therapy increased the odds by nearly 21-fold (aOR 20.88). Abbreviations: aOR, Adjusted Odds Ratio; CI, Confidence Interval; O2, Oxygen.			

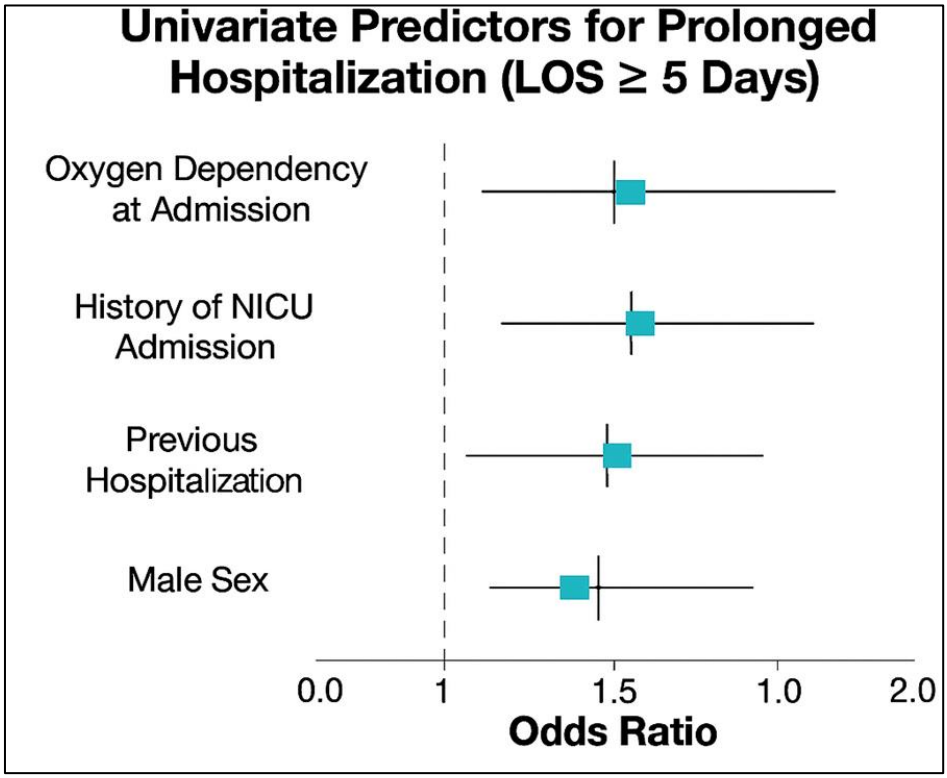

Figure 1 Forest Plot of Univariate Predictors for Prolonged Hospitalization (LOS ≥5 days)

Legend for Figure 1: Forest plot displaying the unadjusted Odds Ratios (OR) and their 95% Confidence Intervals (CI) for factors significantly associated with a prolonged length of stay (LOS ≥5 days) in the univariate analysis. An OR >1 indicates increased odds, while an OR <1 indicates reduced odds. The plot visually demonstrates that oxygen dependency at admission was the strongest univariate predictor, followed by a history of NICU admission and previous hospitalization. Male sex was a protective factor. The dashed vertical line at OR=1 represents the null value. Abbreviations: LOS, Length of Stay; OR, Odds Ratio; CI, Confidence Interval; NICU, Neonatal Intensive Care Unit; O2, Oxygen.

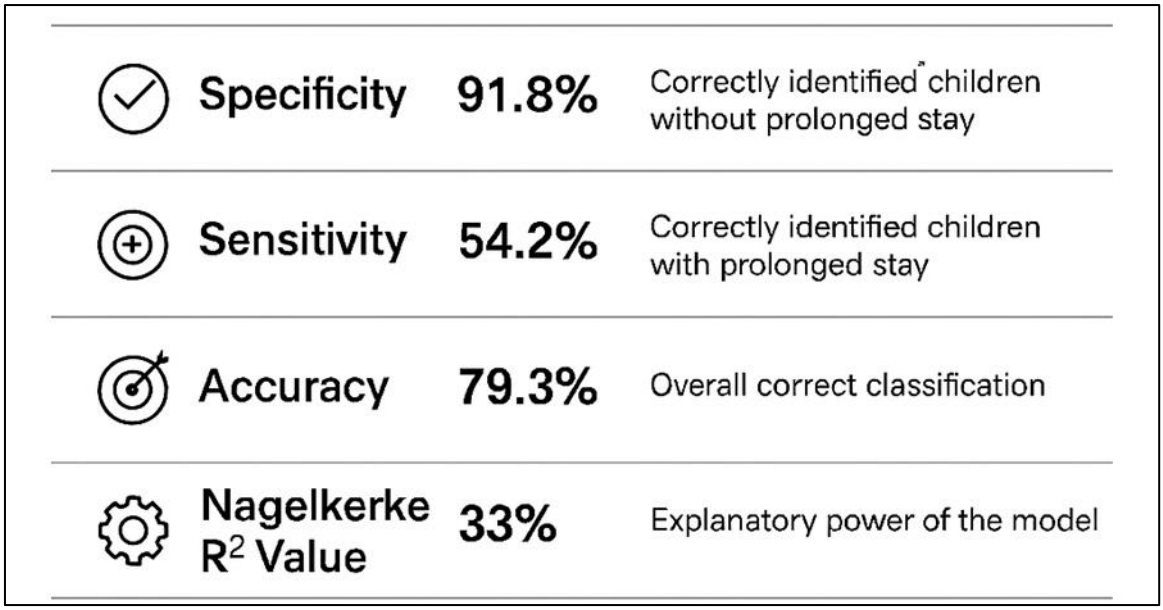

Figure 2 Predictive Performance of the Final Clinical Model

A visual summary of the classification performance for the final predictive model (using Gestational Age and O2 Dependency). The model demonstrated high specificity (91.8%), correctly identifying the majority of children who would not have a prolonged stay. The sensitivity was moderate (54.2%), indicating its ability to correctly identify just over half of the children who would go on to have a long hospitalization. The overall accuracy of the model was 79.3%. The explanatory power of the model, as measured by Nagelkerke R^2, was 33%. Abbreviations: LOS, Length of Stay.

4. Discussion

This historical cohort research sought to identify causes of severe illness, defined as a protracted hospital stay. It provided a complete clinical picture of bronchiolitis severity in Jordanian children. Our key finding is that lower gestational age, a host feature that increases the risk of significant bronchiolitis, and oxygen dependence at entrance, a measure of disease severity, better predict the illness. The final model with just these two parameters demonstrated good sensitivity and overall accuracy, suggesting therapeutic screening use.

Younger foetal age is strongly linked to poorer illness. Molecular reasoning and other studies support this result. Preterm babies' lungs have fewer alveoli and less elastic return. Their immune systems are still developing, therefore they are prone to severe lower respiratory tract infections and require a long time to recover [13, 14]. Our findings match a large multi-center research by Garcia et al., which indicated that being born before 37 weeks of pregnancy was a major independent risk factor for ICU admission [15]. Our more extensive statistical research shows that each additional week of pregnancy is helpful. This gradient of risk has been observed in RSV hospitalisation studies [16].

Our group's best accurate forecast was additional air at appearance. This matches what physicians know and provides a straightforward, objective technique to diagnose severe respiratory problems. Our finding that oxygen intake increased lengthy stay risk by 21 times is alarming, and other research have found the same. A prospective research by Figueras-Aloy et al. indicated that entering oxygen saturation of less than 92% was the most critical predictor in extended LOS [17]. Ma et al. [18] constructed a model to predict PICU admission based on hypoxaemia. Our model has great sensitivity (91.8%), thus it can discover kids without serious course. This helps explain ward situations and soothe families.

Our analysis was noteworthy for how multivariate correction impacted other risk variables. In a one-variable analysis, NICU admissions and hospital stays were relevant, but gestational age and clinical severity made them less influential. This suggests that their influence is indirect, largely via prematureness (NICU entrance) and lung sickness (earlier hospitalisation). Hospitalisation history is an independent risk factor in certain studies [19]. This conclusion differs from prior studies, maybe because our group's two most relevant markers were stronger.

In the final model, being male was not an independent risk factor for increased intensity, contrary to previous research [7, 20]. One-variable research revealed males had a protective benefit, but other variables screwed up this association.

Our group should investigate this startling outcome since it may be attributable to genetic or environmental variations. Similarly, household smoking and eating habits were not linked. Nursing, frequently cited as a protective factor, was insignificant [8]. Our retrospective methodology may have issues like misclassifying eating behaviours or not having enough data to detect a tiny influence among larger variables.

4.1. Limitations

We must consider many factors while interpreting our data. The retrospective technique can't manage unmeasured bias or missing data. Our findings may be tougher to generalise to other groups or hospitals since this research only utilised one facility. Even though figuring out intensity mainly by LOS is generally useful and practical, it can be affected by things that aren't clinical, like how doctors practise and people's personal lives. Also, we didn't have enough information on the virus that caused the disease, which has been shown in some studies to affect how the disease progresses, with RSV and RSV-HRV coinfection being linked to worsening symptoms [21].

5. Conclusion

This statistical profile reveals that in our Jordanian group, the child's immaturity and respiratory condition have the greatest impact on bronchiolitis development. Gestational age and oxygen requirement at admission may confidently place patients in a low-risk category. These results should give doctors at the bedside more information to help them make better choices about where to put patients, how to help parents, and how to use resources. To confirm and improve this prediction model, prospective, multi-center studies should be done in the future that include virus tests and a more complete composite severity score.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors have no financial or non-financial conflicts of interest to declare.

Statement of ethical approval

The study protocol received ethical approval from the Institutional Review Board of the Jordanian Royal Medical Services (Ref: #29_15/2025)

Statement of informed consent

A waiver for individual consent was formally granted for this retrospective analysis.

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