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Original Research Article

Study of risk factors associated with childhood pneumonia in children admitted in tertiary care hospital

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ABSTRACT

Background: Childhood pneumonia remains a major cause of morbidity and mortality in children under five, especially in resource-limited settings like India. This study analysed risk factors influencing pneumonia outcomes among 200 children aged 1 month to 5 years, admitted to a tertiary care hospital from July 2023 to July 2024.
Methods: A total of 200 children aged 1 month to 5 years, admitted with clinical symptoms of pneumonia, were enrolled. Comprehensive demographic and clinical data were collected for each patient. This included a detailed history of symptoms, immunization status, nutritional status, and maternal education levels. Collected data were analysed using standard statistical methods.
Results: Key findings identified incomplete immunization, malnutrition, indoor air pollution, and low maternal education as significant contributors to disease severity and prolonged hospital stays. Fully vaccinated children had better outcomes, while malnutrition and indoor pollution were associated with severe disease and delayed recovery.
Conclusions: Targeted interventions to improve vaccination coverage, nutrition, and maternal education, along with reducing indoor pollution, are essential to alleviate the burden of childhood pneumonia and improve child health outcomes.

Keywords: Childhood pneumonia, Risk factors, Vaccination, Malnutrition, Indoor pollution, Maternal education

INTRODUCTION

Childhood pneumonia remains one of the leading causes of morbidity and mortality among children under the age of five, contributing to approximately 15% of all child deaths globally. According to recent estimates, India bears a disproportionately high burden, accounting for 26% of global childhood pneumonia cases, with over 77,000 deaths annually in the under-five age group. This poses a significant challenge for healthcare systems, particularly in resource-limited settings.[1]

The World Health Organization (WHO) defines pneumonia as an acute respiratory tract infection affecting the lungs. Symptoms include cough, tachypnea, chest wall in drawing, and wheezing, often accompanied by fever. Despite the availability of effective vaccines and antibiotics, pneumonia continues to be a public health concern due to its multifactorial etiology, including nutritional deficiencies, incomplete immunization, low socioeconomic status, and exposure to environmental pollutants such as indoor air pollution.[2]

The burden of childhood pneumonia is further exacerbated by factors such as maternal illiteracy, overcrowding, and inadequate access to healthcare services. In developing countries like India, these risk factors are prevalent and significantly impact disease outcomes, including hospital stay duration, severity, and mortality.[3] This study was conducted to evaluate the risk factors associated with childhood pneumonia and their influence on disease outcomes in a tertiary care hospital setting. By identifying

these determinants, the study aims to contribute to the development of targeted interventions and public health policies to reduce the burden of pneumonia in children.

METHODS

This study was an observational, cross-sectional study conducted in the Department of Pediatrics, M.P. Shah Government Medical College and G.G. Hospital, Jamnagar, over a one-year period from July 2023 to July 2024. The study aimed to evaluate the risk factors associated with childhood pneumonia and their impact on disease outcomes. Institutional ethical clearance was obtained prior to the commencement of the study, and written informed consent was collected from the parents or guardians of all participants.

Study design and population

A total of 200 children aged 1 month to 5 years, admitted with clinical symptoms of pneumonia, were enrolled. Children were included based on the World Health Organization (WHO) criteria for pneumonia, which included signs such as tachypnea, chest wall retractions, and confirmation via chest X-rays. Cases with *Bacteremic pneumonia*, indicated by positive blood cultures for respiratory pathogens, were also included.

Patients with recent hospitalizations for non- respiratory illnesses, recurrent wheezing, or respiratory distress due to metabolic or central nervous system disorders were excluded from the study. The inclusion and exclusion criteria were carefully applied to ensure a representative study population.

Data collection

The flowchart shown in Figure 1 provides a visual representation of the study process. It begins with the enrollment of eligible children, followed by the application of inclusion and exclusion criteria. Subsequently, detailed histories were taken, clinical examinations were conducted, and relevant investigations were performed. The figure emphasizes the systematic approach adopted to ensure reliable data collection and analysis, which forms the basis of this study.

Comprehensive demographic and clinical data were collected for each patient. This included a detailed history of symptoms, immunization status, nutritional status, and maternal education levels. The physical examination focused on key respiratory symptoms such as tachypnea, nasal flaring, central cyanosis, and auscultatory findings, which included wheeze, rhonchi, and crepitations. Additionally, anthropometric measurements, including weight, height, and mid-arm circumference, were recorded to assess nutritional status.

Laboratory investigations were performed, including complete blood counts (CBC), acute phase reactants, blood cultures, and pleural fluid analyses when applicable. Imaging techniques, such as chest X-rays, were utilized to confirm the diagnosis of pneumonia.

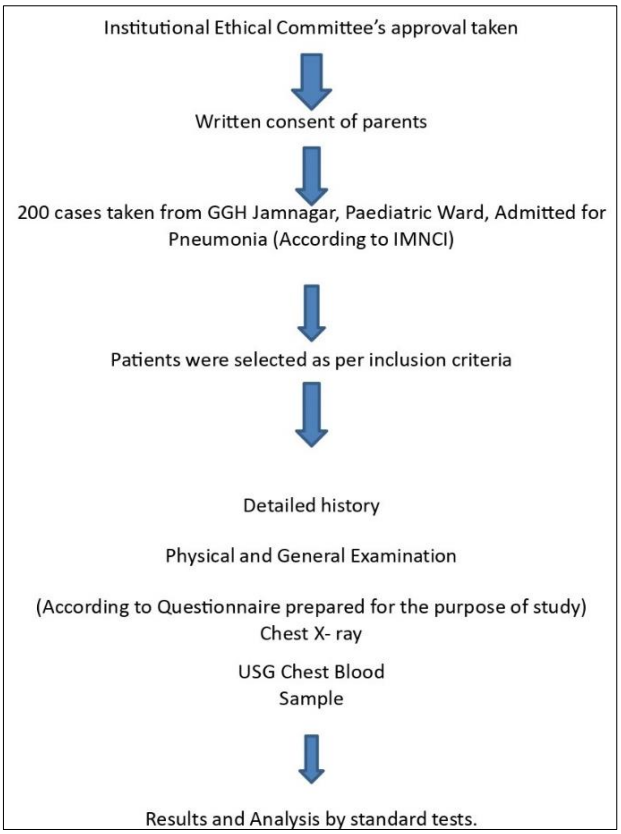

Figure 1: Methodology flowchart illustrating patient enrollment, inclusion and exclusion criteria, and steps in data collection and analysis.

Statistical analysis

Collected data were analyzed using standard statistical methods. Descriptive statistics were used to summarize demographic and clinical characteristics. Associations between risk factors and pneumonia outcomes, such as disease severity and duration of hospital stay, were evaluated using odds ratios with confidence intervals. Statistical significance was assessed to identify key determinants of poor pneumonia outcomes.

RESULTS

Demographic characteristics

The study included 200 children aged 1 month to 5 years who were admitted with pneumonia based on WHO criteria. The demographic characteristics, including age and gender distribution, are summarized in Table 1.

As shown in Table 1, the majority of the study population (55%) were infants aged 1–12 months, indicating their higher vulnerability to pneumonia. Children aged 1–3 years accounted for 30% of cases, while those aged 3–5

years comprised the smallest group at 15%. This trend highlights the importance of targeted interventions during infancy, when susceptibility to infections is highest.

In terms of gender distribution, Table 1 shows a male predominance, with 60% of cases being boys compared to 40% girls. This disparity may reflect a combination of biological factors and societal healthcare-seeking behaviors favoring male children in certain regions.

Table 1: Demographic characteristics of study population.

Category	Number of cases (%)
Age group	
1–12 months	110 (55)
1–3 years	60 (30)
3–5 years	30 (15)
Gender	
Male	120 (60)
Female	80 (40)

Impact of vaccination on pneumonia outcomes

The study assessed the role of vaccination status in influencing pneumonia severity among children. The findings, as illustrated in Table 2, show the distribution of pneumonia severity and its association with vaccination status, along with the corresponding odds ratios. Fully vaccinated children showed a significantly lower proportion of severe pneumonia cases compared to partially vaccinated and unvaccinated children. The odds ratios further highlight that the likelihood of severe pneumonia is substantially higher in unvaccinated children, emphasizing the critical role of vaccination in mitigating pneumonia severity.

As depicted in Table 2, 30.6% of fully vaccinated children presented with severe pneumonia, while the corresponding figures were 48.5% and 81.2% for partially vaccinated and unvaccinated children, respectively. Non-severe pneumonia was more common in fully vaccinated children (70.9%), reflecting the protective effect of immunization. Odds ratios further demonstrate that unvaccinated children were 9 times more likely to experience severe pneumonia compared to fully vaccinated children, and partially vaccinated children had over 2 times the odds of severe disease.

Association of vaccination status with duration of hospital stay

This section explores how vaccination status impacts the duration of hospital stay for children admitted with pneumonia. The data, summarized in Table 3 indicate a clear relationship between vaccination status and hospital stay length.

Table 3 illustrates the association between vaccination status and the duration of hospital stay. Fully vaccinated children exhibited shorter hospital stays, with 65.3% discharged within seven days, compared to 45.7% of partially vaccinated children and only 31.3% of unvaccinated children. Conversely, a higher percentage of unvaccinated children (68.7%) required extended hospitalization beyond seven days, highlighting the protective role of full vaccination.

Odds ratios further reinforce these findings. Partially vaccinated children had over twice the odds of prolonged hospital stays (OR=2.23, p=0.049) compared to fully vaccinated children, while unvaccinated children exhibited a significantly higher likelihood of extended stays (OR=4.14, p=0.005).

Impact of nutritional status on length of hospital stay

This section examines the effect of nutritional status on the length of hospital stay among children with pneumonia. The data presented in Table 4 highlight the significant influence of malnutrition on prolonged hospitalizations.

Table 4 demonstrates that malnourished children are significantly more likely to experience longer hospital stays compared to their well-nourished counterparts. Among malnourished children, 82.8% required hospitalization for more than seven days, whereas this proportion was lower (57.3%) for children with normal nutritional status. The odds ratio (OR=3.61) indicates that malnourished children have more than three times the likelihood of prolonged stays (p=0.045), emphasizing the strong association between malnutrition and extended recovery times.

Impact of malnutrition on pneumonia severity

This section explores the relationship between malnutrition and the severity of pneumonia among children. The data in Table 5 highlight the significant impact of nutritional status on disease outcomes.

Table 5 shows that 58.5% of malnourished children developed severe pneumonia, whereas only 28% of children with normal nutritional status exhibited severe pneumonia. The proportion of non-severe pneumonia cases was higher in well-nourished children (72%) compared to malnourished children (41.5%). The odds ratio of 3.61 indicates that malnourished children are significantly more likely to develop severe pneumonia than their well-nourished counterparts, with a statistically significant p value of 0.001.

Association of maternal education with duration of hospital stay

This section explores the relationship between maternal education level and the duration of hospital stay for children admitted with pneumonia. The findings,

summarized in Table 6 show a significant correlation between lower maternal education and longer hospital stays.

Table 6 demonstrates that mothers with graduate- level education are associated with the shortest hospital stays for their children, with 75% of these children discharged within seven days. In contrast, children of uneducated mothers had the highest proportion (94.3%) of extended hospital stays exceeding seven days. The odds ratio highlights that child of mothers with basic school education had 3.51 times higher odds of longer stays (p=0.025), while those of uneducated mothers had a significantly higher odds ratio of 7.80 (p=0.001).

Association of indoor air pollution with duration of hospital stay

This section examines the impact of indoor air pollution on the duration of hospital stay for children admitted with pneumonia. The findings, summarized in Table 7 highlight the significant relationship between the presence of indoor air pollution and extended hospitalizations.

Table 7 demonstrates that children exposed to in- door air pollution had significantly longer hospital stays, with 88.04% requiring hospitalization for more than seven days compared to 48.19% of those not exposed to indoor pollution. The χ^2 value of 37.8 with a p value of 0.001 indicates a strong statistical association between indoor air pollution and prolonged hospitalizations.

Association of risk factors with duration of hospital stay in pneumonia patients

This section examines the association of various risk factors with the duration of hospital stay for children admitted with pneumonia. The data, presented in Table 8, highlight significant relationships between these factors and prolonged hospitalizations.

Table 2: Effect of vaccination status on pneumonia severity.

Vaccination status	Severe pneumonia (%)	Non severe pneumonia (%)	Odds ratio (95% CI)	P value
Fully vaccinated	30 (30.6)	68 (70.9)	Reference	-
Partially vaccinated	34 (48.5)	36 (51.5)	2.14 (1.1–3.9)	0.02
Unvaccinated	26 (81.2)	6 (18.8)	9 (1.8–9.3)	<0.001

Table 3: Association of vaccination status with duration of stay.

Vaccination status	≤7 days (%)	>7 days (%)	Odds ratio (95% CI)	P value
Fully vaccinated	64 (65.3)	34 (34.7)	Reference	-
Partially vaccinated	32 (45.7)	38 (54.3)	2.23 (0.98–3.21)	0.049
Unvaccinated	10 (31.3)	22 (68.7)	4.14 (1.43–7.89)	0.005

Table 4: Impact of nutritional status on length of stay.

Nutritional status	>7 days (%)	≤7 days (%)	Total
Malnourished	92 (82.8)	19 (17.2)	111
Normal	51 (57.3)	38 (42.7)	89
Total	143	57	200

Odds ratio (OR): 3.61, 95% CI: 1.4–4.1, p value: 0.045

Table 5: Impact of malnutrition on pneumonia severity.

Nutritional status	Severe pneumonia (%)	Non severe pneumonia (%)	Odds ratio (95% CI)	P value
Malnourished	65 (58.5)	46 (41.5)	3.61 (1.4–4.1)	0.001
Normal	25 (28)	64 (72)	Reference	-

Table 6: Association of maternal education with duration of stay.

Maternal education	≤7 days (%)	>7 days (%)	Odds ratio (95% CI)	P value
Graduate	18 (75.0)	6 (25.0)	Reference	-
High school	24 (40.0)	36 (60.0)	2.10 (0.69–6.39)	0.191
Basic school	13 (16.0)	68 (84.0)	3.51 (1.17–10.53)	0.025
Uneducated	2 (5.7)	33 (94.3)	7.80 (2.34–26.03)	0.001

Table 7: Association of indoor air pollution with duration of stay.

Indoor pollution	≤7 days (%)	>7 days (%)	Total
Present	14 (11.96)	103 (88.04)	117
Absent	43 (51.8)	40 (48.19)	83
Total	57	143	200

χ^2=37.8, df=1, p value=0.001

Table 8: Association of risk factors with duration of stay.

Risk factors	Distribution	Duration of stay (%)	P value
Malnutrition			
Present	111	19 (17)/92 (83)	0.045
Absent	89	43 (48)/46 (52)	
Immunization			
Complete	98	64 (65)/34 (35)	0.006
Incomplete	102	42 (41)/60 (59)	
Anemia			
Present	154	29 (19)/125 (81)	0.001
Absent	46	28 (61)/18 (39)	
Indoor house pollution			
Present	117	14 (12)/103 (88)	0.001
Absent	83	43 (52)/40 (48)	
Socioeconomic class			
Lower class	52	12/40	0.038
Upper lower class	28	7/21	
Lower middle class	98	30/68	
Upper middle class	22	12/10	
Maternal education			
Uneducated	35	2 (6)/33 (94)	0.001
Basic school	81	13 (16)/68 (84)	
High school	60	24 (40)/36 (60)	
Graduate	24	18 (75)/6 (25)	
Residence			
Rural	113	53/60	0.142
Urban	87	57/43	
Premature birth			
Present	36	9/27	0.596
Absent	164	48/116	
Low birth weight			
Present	43	11/32	0.610
Absent	157	46/111	
Meconium aspiration			
Present	15	3/12	0.048
Absent	185	86/99	
Exclusive breastfeeding			
Present	115	45/70	0.001
Absent	85	12/73	
Past h/o oxygen use			
Present	45	14/31	0.662
Absent	155	43/112	
Gender			
Male	103	32/71	0.413
Female	97	25/72	

Table 8 highlights the association of various risk factors with the duration of hospital stay. Significant findings include a strong correlation between prolonged hospitalizations and factors such as malnutrition (p=0.0451), incomplete immunization (p=0.0006), anemia (p=0.001), indoor pollution (p=0.001), and lower maternal education (p=0.001).

Malnutrition is strongly associated with longer stays, with 83% of malnourished children hospitalized for more than seven days compared to 52% of well-nourished children. Similarly, 59% of children with incomplete immunization required extended hospital stays compared to 35% of those with complete immunization. Anemia and indoor pollution also show similar trends, emphasizing their role in prolonging hospital stays.

On the other hand, factors such as residence (rural or urban), premature birth, low birth weight, and past history of oxygen use did not show significant associations with the duration of hospital stay, as indicated by their higher p values. These findings underscore the importance of addressing modifiable risk factors such as malnutrition, incomplete immunization, anaemia, and indoor pollution. Public health initiatives targeting these areas, along with improving maternal education, could significantly reduce the burden of prolonged hospitalizations for children with pneumonia.[4]

DISCUSSION

In this study of total 200 admitted children for pneumonia, we studied various risk factors and their effect on outcome of pneumonia.

Among all the risk factors, incomplete immunization, malnutrition, anaemia, indoor air pollution, maternal education and lower socioeconomic conditions were associated with increased morbidity due to pneumonia.

Complete vaccination is very important for overall health status of the child and can prevent severe pneumonia up to a significant extent. Results of this study showed significant reduction in mortality and morbidity due to pneumonia in vaccinated children. A study conducted by Obaro et al concluded that vaccination against Hib and *S. pneumoniae* has led to significant reduction in global childhood pneumonia burden.[5]

Long term use of PCV10 and PCV13 reduced childhood pneumonia mortality and morbidity as concluded by Fathima et al.[6] Introduction of pneumococcal vaccine to national immunization schedule is a significant step towards reducing pneumonia mortality and morbidity in community.[7] According to one estimate by GAVI, introduction of pneumococcal vaccine in universal immunization program (UIP) is likely to reduce childhood mortality due to pneumonia by 60%.[8] A study conducted by Farooqui et al estimated that in 2010, 3.6 million episodes of severe pneumonia and 0.35 million pneumonia deaths occurred in children less than 5 years in India. Out of which 0.56 million cases and over 1 lakh deaths were due to pneumococcal pneumonia.[9]

Malnourished children had more chances of severe pneumonia and longer hospital stay. Malnourished children are prone to infections and recurrent illness further worsens the nutritional status leading to vicious cycle. Anaemia is also very common in malnourished children. Improving nutritional status can reduce pneumonia morbidity and mortality significantly. Yellanthoor et al in their study to find out prevalence of malnutrition among under five-year-old children with acute respiratory tract infection hospitalized at Udupi district hospital found that severe malnutrition in 54.9% patients of LRTI presented with malnutrition, which was similar to this study (55.5%).[10] A study by Kirolos et al concluded that odds ratio of death from pneumonia was 2.0 (95% CI 1.6 to 2.6) and 4.6 (95% CI 3.7 to 5.9) for children moderately and severely underweight, respectively.[11]

Parental education affects child's nutritional status significantly. Children of educated parents were having higher rates of exclusive breastfeeding, good feeding practices, early identification of danger signs, timely hospital visits, complete vaccination. Overall, it reduces burden of pneumonia in paediatric population significantly. A study conducted by Parvez et al in Bangladesh suggested that success of ARI control program depends on recognition of danger signs by primary caretaker and subsequent contact if necessary. Study revealed that only 59.9% of primary caretaker could identify danger signs and 58.4% sought help in presence of danger signs. These findings indicate the necessity and importance of providing education to mothers as they are the main care provider in family.[12]

Reduced usage of biomass fuel for household cooking and heating can improve air quality indoors and ultimately reduces chances of pulmonary complications in children. Lack of adequate ventilation, overcrowding, passive smoking is also associated with increased risk of pneumonia and prolonged hospital stay. Pembe et al in their study observed that passive smoking was present in 76.7% children hospitalised with pneumonia and it concluded that passive smoking is an important risk factor for development of pneumonia.[13] An article published in National Health Survey Bulletin by Mishra et al stated that a large national household survey in India found a statistically significant relationship (OR 1.3) between reported use of household biomass fuel and reported incidence of respiratory infection in the previous week among children under 5 years.[14]

Naz et al in their study concluded that in bivariate regression, odd ratios of childhood pneumonia were 1.27 and 1.21 times higher in overcrowded houses in 2006-2007 and 2012-2013, respectively, and 1.25 times higher in families relying on biomass for cooking in 2017-2018.[15]

Small sample size limits the application of results on community level. Larger sample size is required to further increase the accuracy of the study. Inclusion of non-hospitalised patients can help study the disease aetiology and risk factors with higher accuracy.

CONCLUSION

This study highlights the significant risk factors associated with childhood pneumonia among children aged 1 month to 5 years admitted to a tertiary care hospital. Incomplete immunization, malnutrition, indoor air pollution, low maternal education, and lower socioeconomic status were identified as key determinants influencing pneumonia severity, prolonged hospital stays, and mortality. Fully vaccinated children demonstrated better outcomes, with lower severity and shorter hospital stays, while malnourished children and those exposed to indoor air pollution were more prone to severe disease and delayed recovery. Maternal education also played a critical role, as children of uneducated mothers had significantly poorer outcomes.

Recommendations

Addressing these modifiable risk factors through improved vaccination coverage, enhanced nutrition, reduced household air pollution, and maternal education can effectively reduce the burden of childhood pneumonia. Integrated healthcare policies and targeted community interventions are essential to improving child health outcomes, particularly in resource-limited settings.

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