**Original Article**

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# Comparison of Treatment Outcomes in Childhood Pneumonia with or without Rickets

**Noor ul Huda[1], Masood Mazhar Sahu[2], Anam Fatima[3], Tehreen Fatima [4], Imran Ahmad[5], Abdul Basit Memon[6]**

[1]Postgraduate resident, Pediatric Medicine department, Reccep Tayyap Erdogan Hospital Muzaffargarh
[2]Senior Consultant, Pediatric Medicine department, Reccep Tayyap Erdogan Hospital Muzaffargarh
[3,4]FCPS Paeds medicine from Indus hospital-RTEH Muzaffargarh
[5]Associate Professor of Paediatrics. Isra University Hospital, Hyderabad
[6]Senior Registrar , Isra university Hospital, Hyderabad

Author`s Contribution

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***Address of Correspondent***
*Dr. Noor ul Huda*
*Post graduate resident, Pediatric Medicine department, Reccep Tayyap Erdogan Hospital Muzaffargarh*
*noorulhuda19111997@gmail.com*

**ABSTRACT**

Objective: To compare the treatment outcomes among children with pneumonia with or without rickets presentation.

Methodology: This comparative study was conducted on 190 children diagnosed with pneumonia, who were divided into two equal groups: 95 children with rickets and 95 without rickets. Study was done at Department of Pediatric Medicine, Recep Tayyip Erdogan Hospital Muzaffargarh. The rickets was diagnosed based on clinical features and radiological and biochemical findings. Patients received standard pneumonia management according to institutional guidelines. Treatment outcomes were assessed in terms of duration of fever, need for oxygen therapy, length of hospital stay, and treatment failure, across the groups. Data were analyzed using appropriate statistical tests, and a *p*-value of < 0.05 was considered statistically significant.

Results: Paediatric patients with rickets showed a significantly longer duration of fever (p=0.001) and prolonged stay in Hospital stay p=0.001 compared to non-rickets patients. Failure of treatment was more frequent in the rickets group (22.1 % vs 9.5 %) p = 0.018. The severe pneumonia and oxygen requirement were significantly higher in children with rickets in contrast to non-rickets patients (31.6 % vs 15.8 %) and (48.4 % vs 27.4 %), p= 0.004 respectively. Average clinical recovery time was also significantly delayed in children with rickets. Additionally, the rate of complications also being significantly higher among children with rickets, while the mortality rate was low and almost similar across the p=0.05).

Conclusion: The childhood pneumonia with rickets was observed with significantly poor treatment outcomes, and these patients required more intensive supportive care and showed delayed recovery compared to those without rickets.

Key words: Pneumonia, Rickets, Children, Treatment failure, Mortality.

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## Introduction

Pneumonia is globally recognized as one of the leading causes of childhood mortality, especially among children between 6 to 60 months of age worldwide.[1] It ranks as the 2nd most common cause of mortality in this age group, responsible for more than 30,000 deaths per year.[2] Regardless advances in antibiotic therapy and vaccination coverage, failure of treatment and prolonged hospital stays continue to pose a major challenges clinically, specifically in resource-limited settings where underlying nutritional deficiencies are predominant.

The Rickets, is a metabolic bone disease produced mainly by deficiency of vitamin D, decreased level of calcium, or phosphate, remains a considerable public health concern in developing populations, mostly characterized by widening and flaring of the metaphysis of bones, subsequent in enlargement of the wrist joints, prominence of the costochondral junctions of the ribs, knock-knees,

and bowed legs.[3] Middle Eastern, African and Asian countries report an extensive prevalence of rickets among child population with prevalence of it 15-18% in the South Asia and 10% in the Africa.[3] The risk factors for developing vitamin D deficiency rickets incorporate inadequate exposure to sunlight, exclusive breastfeeding without supplementation of vitamin D and insufficient dietary intake of vitamin D, phosphorus or the calcium. In Pakistan and similar low-income settings, these risk factors are widely prevalent due to poverty, malnutrition, and limited access to preventive healthcare facilities.[4]

The diagnosis of nutritional rickets is primarily made through clinical assessment, including the medical history and physical examination of the patients, further supported by biochemical investigations and ultimately verified through radiographic parameters.[5] However, the nutritional rickets can lead to several health complications, like decreased linear growth, chest wall deformities that raise the susceptibility to pneumonia, fractures, pain of the bones, and lower limbs deformities. Moreover, affected children may happening delays in gross motor development, and in cases with severe condition, life-threatening complications may occur, including hypocalcemia related seizures, and cardiovascular events.[5-7]

The relationship between rickets and pneumonia is of particular clinical importance and the treatment outcomes has been explored in a limited number of studies. The epidemiological studies have decisively established the link between nutritional rickets and the risk of pneumonia development, as according to a study conducted in Ethiopia reported that, there was a 13-fold greater incidence of rickets among children with pneumonia than among controls, indicating that the deficiency of vitamin D or calcium may be important predisposing factors for pneumonia in children under 5 years in developing nations.[8]

In the same way, the Nepalian study measured plasma 25(OH)D concentrations among 568 children hospitalized with WHO-defined severe pneumonia and found that plasma 25(OH)D levels below 50 nmol/L were corelated with the raised risk of treatment failure and prolonged duration for recovery.[9] Such previous findings underscore the potential of rickets as an important modifiable risk factor influencing clinical outcomes in pneumonia among children. In spite of this growing evidence base, comparative data on treatment outcomes specifically between rachitic and non-rachitic children with pneumonia remain very limited, specifically from South Asian settings including Pakistan where both conditions are highly frequent. However present study was therefore planned to compare treatment outcomes, including treatment failure, time to fever resolution, normalization of respiratory rate, and duration of hospital stay, among children with pneumonia with and without co-existing rickets, in order to produce locally relevant evidence that may inform clinical management and highlight the nutritional screening importance among children hospitalized with pneumonia.

# Methodology

A prospective comparative cohort study was conducted in the Department of Pediatric Medicine at Recep Tayyip Erdogan Hospital from January 2025 to June 2025. Ethical approval was obtained from the hospital's ethics committee (Ref. No. IHHN_IRB_2024_12_003).

All children aged 2 to 12 years, of either gender, presenting with pneumonia as per the operational definition were included. Pneumonia was defined as the presence of cough, fever (axillary temperature >100°F), and increased respiratory rate (>50 breaths/min in children aged 2–11 months, >40 in 2–5 years, and >30 in children older than 5 years), with a duration of ≤72 hours. Children with and without rickets were included.

Exclusion criteria included children with chronic lung diseases (such as asthma, cystic fibrosis, or post-tuberculosis bronchiectasis based on history and medical record review), immunosuppressed children, and those whose parents did not consent to participate.

Children were enrolled after obtaining informed consent from their parents. Baseline data—including age, gender, history of exclusive breastfeeding, nutritional status, and vaccination status—were recorded. A detailed clinical examination was performed in all participants to identify bony manifestations of rickets. Additionally, 3 mL of venous blood was collected from each child for biochemical analysis.

Rickets was diagnosed based on the operational definition: the presence of one or more bony abnormalities (such as bowing of the legs, knock knees, rachitic rosary, swelling of the ends of long bones, or frontal bossing) along with biochemical abnormalities, including serum 25-hydroxyvitamin D levels <20 ng/mL, serum calcium <8.5 mg/dL, low phosphorus levels, elevated alkaline phosphatase (>350 IU/L), and serum phosphate <4.0 mg/dL.

Participants were categorized into two groups: the exposed group (rickets-positive) and the unexposed group (without rickets). All children received standard management, including oxygen therapy, intravenous antibiotics, and treatment for rickets (where applicable), according to institutional protocols.

Patients were followed until their final outcomes. Treatment failure was defined as the absence of clinical improvement within 48–72 hours of initiating standard antibiotic therapy, indicated by persistent fever (>38.5°C), ongoing respiratory distress, or oxygen saturation below 95%, necessitating a change in antibiotics or admission to the intensive care unit.

Additionally, time to fever resolution, normalization of respiratory rate, and duration of hospital stay were recorded. All data were entered into a structured proforma and analyzed using SPSS version 23.

## Results

This study enrolled 100 patients, which were further equally divided into two groups; 50 in each group. Overall majority of boys (60%), and most children were not exclusively breastfed (67%). The malnutrition was uncommon overall, affecting only 9% of the total sample, while it was slightly more prevalent in the rickets group (12%) compared to the non-rickets group (6%). According to the vaccination status, around half of all children were partially vaccinated (48%) and the other half fully vaccinated (48%), with only 4 unvaccinated children, all from the unexposed group. Overall baseline characteristics, were statistically insignificant across the groups (p >0.05). Table I

In this study the treatment failure was noted higher in cases of rickets group 8% compared to the non-rickets group (2%). Moreover, exposed group approximately 4 times more likely to have treatment failure than those without rickets (OR 4.261, 95% CI: 0.459–39.544), indicating the presence of rickets is associated with higher risk of poor treatment response in childhood pneumonia, while this association did not reach statistical significance given the wide CI, possibly due to the very limited number of failure events. Figure 1.

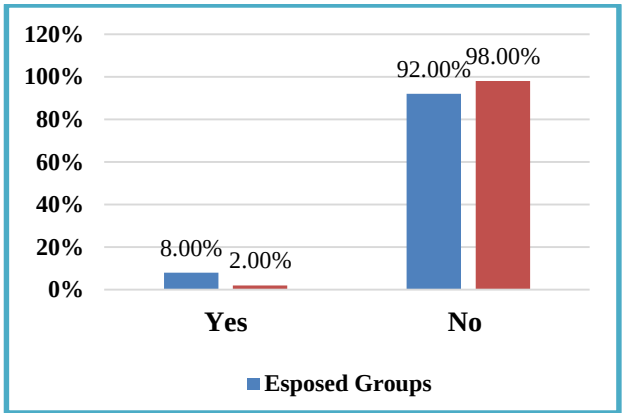



**Figure 1. Frequency of treatment failure in both groups. (n=100)**

Overall the children presented with rickets had significantly worse recovery outcomes compared to those without rickets, particularly as the fever took more than twice as long to resolve in the rickets group (6.32 days) compared to the non-rickets group (3.12 days) (p=0.001). Likewise, normalization of respiratory rate was also

**Table I: Bassline and clinical characteristics of patients in both groups. (n=100)**

| VARIABLES | | STUDY GROUPS | | Total | p-value |
|---|---|---|---|---|---|
| | | Exposed (Rickets positive) | Unexposed (Without rickets) | | |
| Gender | Boys | 32 | 28 | 60 | 0.309 |
| | | 64.0% | 56.0% | 60.0% | |
| | Girls | 18 | 22 | 40 | |
| | | 36.0% | 44.0% | 40.0% | |
| Exclusive breastfeeding | Yes | 16 | 17 | 33 | 0.529 |
| | | 32.0% | 34.0% | 33.0% | |
| | No | 34 | 33 | 67 | |
| | | 68.0% | 66.0% | 67.0% | |
| Malnutrition | Yes | 6 | 3 | 9 | 0.505 |
| | | 12.0% | 6.0% | 9.0% | |
| | No | 44 | 47 | 91 | |
| | | 88.0% | 94.0% | 91.0% | |
| Vaccinated status | Unvaccinated | 0 | 4 | 4 | 0.063 |
| | | 0.0% | 8.0% | 4.0% | |
| | Partially vaccinated | 26 | 22 | 48 | |
| | | 52.0% | 44.0% | 48.0% | |
| | Fully vaccinated | 24 | 24 | 48 | |
| | | 48.0% | 48.0% | 48.0% | |

**Table II: Comparison of recovery outcomes in both groups. (n=100)**

| Variables | Study groups | N | Mean | SD | p-value |
|---|---|---|---|---|---|
| Time to fever resolution (days) | Exposed (Rickets positive) | 50 | 6.32 | 1.86 | 0.001 |
| | Unexposed (Without rickets) | 50 | 3.12 | 1.25 | |
| Time to normalization of respiratory rate (days) | Exposed (Rickets positive) | 50 | 8.48 | 3.58 | 0.001 |
| | Unexposed (Without rickets) | 50 | 3.20 | 1.61 | |
| Duration of Hospital stay (days) | Exposed (Rickets positive) | 50 | 12.24 | 4.35 | 0.001 |
| | Unexposed (Without rickets) | 50 | 5.88 | 1.68 | |

significantly delayed in rickets group (8.48 days) in contrast to children without rickets (3.20 days) (p=0.001). Additionally, the mean Hospital stay was also noted longer in the rickets group (12.24 days) compared to the non-rickets group (5.88 days) (p=0.001), as presented in table: II.

# Discussion

The nutritional rickets is associated to poorer clinical outcomes and a prolonged disease course in children with pneumonia, often demanding repeated changes in antibiotic therapy. Both conditions are highly frequent in our population and are main contributors to childhood morbidity; though, there is very limited data evaluating how rickets influences the clinical progression and recovery of pneumonia among children.[10] This study was comparatively conducted to evaluate the impact of rickets on the course of pneumonia by comparing important clinical features and symptom resolution between pediatric patients with and without rickets, and there were boys in majority 60% compared to girls 41% and this gender analysis was almost similar to the study by Jamal A et al[10] where male patients were 68 (56.1%) and female patients were 53 (43.8%).

In this study the treatment failure rate was significantly higher 8% in the rickets group compared to 2% only in non-rickets group, representing a fourfold difference. These findings were aligned with few other investigations, like Banajeh et al[11] conducted a prospective cohort study on 152 children with WHO-defined very severe pneumonia, stated that treatment failure occurred in 24 children overall, with 21 of those (20.6%) being rachitic, which was significantly higher among in rachitic children compared to the non-rachitic children (6%) (OR 1.38, *P*=0.031]. In the study by Jakhar SK et al[12] also reported that the children with sign of rickets had significantly higher rate of treatment failure 7 (47%) (p=0.054), prolonged Hospital stay 18 (36%) (p=0.019) and need for change in antibiotics 15 (44%) (p=0.002). Additionally, a Nepalese study measuring plasma 25(OH)D in 568 children hospitalized with severe pneumonia found that vitamin D levels below 50 nmol/L were independently correlated with raised risk for treatment failure and prolonged recovery duration, significantly associating subclinical vitamin D insufficiency often the precursor to clinical rickets with the adverse outcomes.[13] Furthermore in the study by Jamal A et al[10] observed that the Hospitalized children with pneumonia and rickets identified with prolonged and significantly delayed clinical recovery, specifically in resolution of fever, tachypnea, cough, and return to normal feeding in contrast to those without rickets.[10] In aligns to our findings Lakshmi M et al[14] demonstrated that the according to their multivariate regression analysis the infancy, incomplete immunization, malnutrition, severity of anemia, clinical signs of rickets, temperature, and baseline hypoxia were the significant predictors of treatment failure, specifically for signs of rickets failure rate was 22 (51.16%) compared to 41 (21.40%) among those without signs of rickets (p=0.015). The delayed recovery from pneumonia and higher treatment failure rate among children with rickets may because the rickets and its underlying vitamin-D deficiency impair immune function, oxygenation, and overall flexibility in nutritional status, leading to sluggish clearance of infection and more complications.

Furthermore, in this study the rickets group showed significantly longer duration to achieve fever resolution (mean 6.32 ± 1.86 days vs. 3.12 ± 1.25 days), normalization of respiratory rate (mean 8.48 ± 3.58 days vs. 3.20 ± 1.61 days) and hospitalization (mean 12.24 ± 4.35 days vs. 5.88 ± 1.68 days), in rickets group versus non-rickets group (p=0.001). In aligns to this series, the Jamal A et al[10] in their cohort of 121 hospitalized children aged 1–5 years with pneumonia, reported that, those with rickets experienced a significantly prolonged time to clinical stabilization compared to children without rickets.

Jamal A et al.[15] reported that children with pneumonia and coexisting rickets require a significantly longer time to achieve normalization of respiratory rate compared to those with pneumonia alone. Similarly, Haugen J et al.[13] observed that children with lower vitamin D levels (25(OH)D <50 nmol/L) had higher rates of treatment

failure and experienced delayed recovery in cases of severe lower respiratory tract infections.

In addition, Piloya et al.[16], in their cross-sectional study of 221 children aged 2–59 months with severe pneumonia, reported a 9.5% prevalence of nutritional rickets. They highlighted that rickets is a common comorbidity in children admitted with pneumonia, even in tropical regions with abundant sunlight, and recommended routine screening for rickets in all children presenting with severe pneumonia.

In this study the exclusive breastfeeding was found in 32% of the group and 34% of the non-rickets group, and malnutrition was identified among 12% of children with rickets contrasted with 6% of children without rickets. Such patterns were closely parallel with other studies like Altaib RM et al[17] reported that the 62% of the participating children exhibited signs of rickets along with low level of vitamin D. Particularly, exclusive breastfeeding during the early months of life was reported in 74% of the children. Comparable trends have been studied in other studies; where reported that the most of the of children who developed rickets were exclusively breastfed.[18-19] Overall in the several low-resource countries like ours, the exclusive breastfeeding is very common and often prolonged without vitamin-D supplementation, which significantly raise the risk of nutritional rickets among infants and young children. However, the condition, in turn, is significantly linked to delayed recovery and higher treatment failure among children with pneumonia, may because the vitamin-D deficiency impairs immunity, worsens hypoxemia, and decreases overall nutritional replacement. Overall the substantial proportion of rachitic children in recent studies are exclusively breastfed,[16,18,20,21] ensuring routine vitamin-D supplementation from early infancy is very important and cost-effective measure to prevent rickets and thereby improve pneumonia outcomes in the children. This study has several limitations, including a relatively limited sample size and a single-center design, which may affect generalizability and increases the risk of selection bias. Consequently, it is strongly recommended that large-scale, multicenter studies be conducted to confirm the findings and more precisely quantify the impact of rickets on pneumonia outcomes among children.

# Conclusion

The children with rickets and parallel pneumonia observed with significantly higher treatment failure rate and longer recovery, in terms of prolonged fever, delayed respiratory recovery, and extended hospitalization in contrast to children without rickets underscoring the adverse impact of rickets on pneumonia outcomes. Generally, findings highlighted the need for early screening and correction of vitamin-D deficiency and rickets, along with routine vitamin-D supplementation, to decrease the failure rate of treatment and improve recovery among children with pneumonia.

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