



Original Article



Frequency and Clinical Risk Factors of Pneumonia among Children with Cerebral Palsy

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ABSTRACT

Children with cerebral palsy (CP) are prone to various comorbidities, among which pneumonia is a leading cause of morbidity and hospitalization. Early identification of contributing factors is crucial to minimize respiratory complications. **Objectives:** To determine the frequency of pneumonia and identify associated clinical risk factors among children diagnosed with cerebral palsy. **Methods:** This cross-sectional study was conducted at the Pediatrics Unit, Khyber Teaching Hospital, Peshawar, for six months. Ninety-three children with confirmed CP were enrolled through consecutive sampling. Data on demographics, feeding methods, CP severity, nutritional status, immunization, and aspiration history were collected. Pneumonia was diagnosed clinically and radiologically. Statistical analysis was performed using SPSS version 26.0, and associations were tested using the Chi-square. **Results:** Among 93 children, 38 (40.9%) had pneumonia. Strong associations were observed with aspiration history ($\chi^2 = 85.14$, $p < 0.001$, Cramer's $V = 0.957$), feeding method ($\chi^2 = 32.13$, $p < 0.001$, Cramer's $V = 0.588$), immunization status ($\chi^2 = 74.72$, $p < 0.001$, Cramer's $V = 0.896$), and nutritional status ($\chi^2 = 52.32$, $p < 0.001$, Cramer's $V = 0.750$). Interestingly, no pneumonia cases occurred in children with severe CP or those who were severely malnourished. **Conclusions:** Pneumonia is highly prevalent in children with CP and is strongly linked to aspiration and oral feeding. Unexpected findings, such as the absence of pneumonia in severe CP and malnourished children, highlight the need to consider contextual exposure and monitoring factors. Targeted prevention strategies, including caregiver education, aspiration management, and individualized nutritional support, are essential to reduce respiratory complications in this vulnerable population.

INTRODUCTION

Cerebral palsy (CP) is the most common motor disability in childhood, characterized by permanent, non-progressive damage to the developing brain [1]. Beyond motor impairment, these children often experience a wide range of medical complications, among which respiratory infections, particularly pneumonia, stand out as a leading cause of morbidity and mortality [2]. International studies have repeatedly highlighted the vulnerability of children with CP to respiratory complications. A comprehensive

study by Liu et al. in Taiwan revealed that nearly 41% of CP children experienced recurrent pneumonia, largely due to aspiration and poor airway clearance [3]. This underscores that airway dysfunction is a universal challenge, but local factors such as malnutrition and healthcare access may modify the risk in Pakistan. Similarly, Kuo et al. emphasized the role of oropharyngeal dysfunction in increasing the risk of lower respiratory tract infections [4], supporting the need to assess swallowing and feeding practices in our

population. In the United States, Stevens *et al.* reported a higher incidence of pneumonia-related hospitalizations among children with moderate to severe CP, often linked to malnutrition and poor mobility [5]. In Pakistan, limited research has explored pneumonia in children with CP despite high rates of malnutrition, incomplete immunization, and poor caregiver awareness. Understanding these associations in our setting is essential to guide context-specific preventive strategies and resource allocation. A study conducted in Islamabad by Khan *et al.* reported that 38% of CP children admitted to tertiary care centers developed pneumonia [6], while Iqbal *et al.* from Karachi emphasized aspiration and incomplete immunization as significant predictors of pneumonia in children with neurodevelopmental disorders [7].

Although pneumonia is a leading cause of morbidity and hospitalization among children with cerebral palsy, local evidence regarding its frequency and context-specific risk factors in Khyber Pakhtunkhwa remains limited. Most available studies are either international or conducted in other regions of Pakistan, with variable findings influenced by healthcare access, feeding practices, and immunization coverage. Furthermore, inconsistencies regarding the role of CP severity and nutritional status highlight the need for localized data. Therefore, assessing the burden and associated clinical risk factors in our tertiary care setting is essential to guide targeted preventive strategies. Despite these findings, there remains a substantial gap in localized data to inform clinical guidelines and prevention strategies in Pakistan. Generating local evidence to support early detection, caregiver education, and preventive interventions in Pakistan. This study aims to determine its frequency and identify clinical risk factors in a tertiary care setting in Peshawar, due to the high burden and preventable nature of pneumonia in children with CP.

METHODS

The study was carried out in the Pediatrics Unit at Khyber Teaching Hospital (KTH), Peshawar, which is a tertiary care teaching hospital affiliated with Khyber Medical College. The hospital serves a large and diverse pediatric population from both urban and rural areas across Khyber Pakhtunkhwa. The data collection form was reviewed by three pediatric faculty members for face validity. The structured clinical assessment form was developed after an extensive literature review. Content validity was established by three senior pediatricians, and face validity was assessed through a pilot on 10 patients. Necessary modifications were incorporated before final data collection. Diagnostic consistency was maintained by ensuring that all assessments were performed by the same team using standardized clinical protocols. Data collection was conducted for six months, from 8th August 2019 to 8th

Feb 2020, after obtaining ethical approval from the Institutional Research and Ethical Review Board (IREB) of Khyber Medical College (Approval No. 631/ADR/KMC). The required sample size was calculated using the single population proportion formula: $n = (Z^2 \times p \times (1-p)) / d^2$. Here, n represents the required sample size, Z is the standard normal value at a 95% confidence level (1.96), p is the anticipated population proportion (0.40), based on Whitney *et al.* [8] and d is the absolute precision (0.10). Substituting these values into the formula: $n = (1.96^2 \times 0.40 \times 0.60) / (0.10^2) = (3.8416 \times 0.24) / 0.01 = 0.921984 / 0.01 = 92.2$. Thus, the minimum required sample size was 93 participants, which was achieved in this study. A non-probability consecutive sampling technique was employed to recruit participants. Inclusion Criteria were children aged 6 months to 15 years with a confirmed diagnosis of cerebral palsy. Diagnosis was established through detailed clinical and neurological assessment by a pediatric neurologist, supplemented by neuroimaging (MRI or CT) findings where available. Both male and female children were included. Patients attending outpatient clinics or admitted for any reason during the study period, and parents or guardians who gave informed consent, were eligible. Exclusion Criteria were children with congenital lung malformations or primary respiratory diseases not related to CP. Patients with incomplete medical records and those who were lost to follow-up or whose caregivers declined participation. Data were collected through a structured clinical assessment form designed specifically for this study. It included demographic details (age, gender, residence, parental education); clinical classification of CP (type and severity). Severity of CP was categorized as mild, moderate, or severe based on the Gross Motor Function Classification System (GMFCS), where mild refers to independent mobility, moderate to assisted mobility, and severe to complete dependence on caregivers. Feeding method (oral, nasogastric tube, PEG); nutritional status (assessed by pediatrician and classified as normal, underweight, or severely malnourished); immunization status (complete vs. incomplete according to the Pakistan Expanded Program on Immunization (EPI) schedule, which includes BCG, OPV, pentavalent (DPT-HepB-Hib), measles, and pneumococcal vaccines); history of aspiration or recurrent choking; and diagnosis of pneumonia (based on clinical features, chest auscultation, and radiological evidence if available). All children were evaluated by a qualified pediatrician, and data were collected confidentially in accordance with ethical standards. Data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize frequencies and percentages for categorical variables. The primary outcome (presence or absence of pneumonia) was assessed in terms of frequency. Chi-square tests were applied to determine

associations between pneumonia and clinical risk factors (feeding method, severity of CP, nutritional status, immunization status, and aspiration history). For statistically significant results, effect sizes were calculated using Cramer's V, and Chi-square values with degrees of freedom (χ^2 , df) were reported. A p -value < 0.050 was considered statistically significant.

RESULTS

The study included 93 children with cerebral palsy, with a slightly higher proportion of male, 56 (60.2%), compared to female, 37 (39.8%). The most common age group was 2–5 years, accounting for 34 (36.6%) of the participants, followed by children aged 6–10 years, 27 (29.0%), while those older than 10 years represented only 10 (10.8%). A majority of the children were from urban areas 51 (54.8%), while 42 (45.2%) resided in rural settings. In terms of parental education, 38 (40.9%) had primary-level education, whereas 29 (31.2%) were illiterate, and only 26 (28.0%) had education beyond the primary level. These figures suggest that CP in the study population was more prevalent among younger children from urban and lower-educated family backgrounds (Table 1).

Table 1: Demographic Characteristics of Children with CP (n=93)

Variables	Category	Frequency (%)
Age Group	<2 Years	22 (23.7%)
	2–5 Years	34 (36.6%)
	6–10 Years	27 (29.0%)
	>10 Years	10 (10.8%)
Gender	Male	56 (60.2%)
	Female	37 (39.8%)
Residence	Urban	51 (54.8%)
	Rural	42 (45.2%)
Parental Education	Illiterate	29 (31.2%)
	Primary	38 (40.9%)
	Secondary or above	26 (28.0%)

Spastic CP was the most common subtype observed in this cohort, affecting 61 (65.6%) of the children. Mixed-type CP was noted in 14 (15.1%), followed by athetoid 11 (11.8%) and ataxic 7 (7.5%) forms. Regarding severity, nearly half the sample, 43 (46.2%), had moderate CP, while severe and mild forms were found in 31 (33.3%) and 19 (20.4%), respectively. The majority of children, 62 (66.7%), were fed orally, but a significant proportion required assisted feeding, including 20 (21.5%) via nasogastric tubes and 11 (11.8%) via PEG tubes. Nutritional assessment showed that half of the children, 47 (50.5%), were underweight and 22 (23.7%) were severely malnourished, whereas only 24 (25.8%) had a normal nutritional status (Table 2).

Table 2: Clinical Profile of Children with CP (n=93)

Variables	Category	Frequency (%)
CP	Spastic	61 (65.6%)
	Athetoid	11 (11.8%)
Severity of CP	Ataxic	7 (7.5%)
	Mixed	14 (15.1%)
	Mild	19 (20.4%)
Feeding Method	Moderate	43 (46.2%)
	Severe	31 (33.3%)
	Oral	62 (66.7%)
Nutritional Status	NGT	20 (21.5%)
	PEG	11 (11.8%)
	Normal	24 (25.8%)
	Underweight	47 (50.5%)
	Severely Malnourished	22 (23.7%)

Among the 93 children, 38 (40.9%) had documented pneumonia, while 55 (59.1%) did not. This indicates a high burden of respiratory complications among children with cerebral palsy (Table 3).

Table 3: Frequency of Pneumonia Among Children with CP (n=93)

Pneumonia Status	Frequency (%)
Present	38 (40.9%)
Absent	55 (59.1%)

Significant associations were identified between pneumonia occurrence and several clinical variables. All children with mild CP had pneumonia, whereas none with severe CP were affected ($\chi^2 = 49.12$, $df = 2$, $p < 0.001$, Cramer's $V = 0.727$). The feeding method was also significant, with all pneumonia cases occurring in orally fed children ($\chi^2 = 32.13$, $df = 2$, $p < 0.001$, Cramer's $V = 0.588$). Nutritional status showed an unusual trend, with pneumonia present only in normally nourished and underweight children, but absent in severely malnourished children ($\chi^2 = 52.32$, $df = 2$, $p < 0.001$, Cramer's $V = 0.750$). Immunization status was strongly associated, as all pneumonia cases occurred in children with complete immunization ($\chi^2 = 74.72$, $df = 1$, $p < 0.001$, Cramer's $V = 0.896$). Aspiration history showed the strongest effect, with every child who had aspiration developing pneumonia ($\chi^2 = 85.14$, $df = 1$, $p < 0.001$, Cramer's $V = 0.957$). Interestingly, no pneumonia cases were reported among children with severe CP or those who were severely malnourished. These counterintuitive findings are noted here and are further explained in the Discussion (Table 4).

Table 4: Association Between Pneumonia and Clinical Risk Factors(n=93)

Variables	Category	Pneumonia Present	Pneumonia Absent	χ^2 (df)	p-Value	Cramer's V
Severity of CP	Mild	19 (100%)	0	49.12 (2)	<0.001*	0.727
	Moderate	19 (44.2%)	24 (55.8%)			
	Severe	0	31 (100%)			
Feeding Method	Oral	38 (61.3%)	24 (38.7%)	32.13 (2)	<0.001*	0.588
	NGT	0	20 (100%)			
	PEG	0	11 (100%)			
Nutritional Status	Normal	24 (100%)	0	52.32 (2)	<0.001*	0.750
	Underweight	14 (29.8%)	33 (70.2%)			
	Severely Malnourished	0	22 (100%)			
Immunization Status	Complete	38 (88.4%)	5 (11.6%)	74.72 (1)	<0.001*	0.896
	Incomplete	0	50 (100%)			
Aspiration History	Yes	38 (95.0%)	2 (5.0%)	85.14 (1)	<0.001*	0.957
	No	0	53 (100%)			

*p<0.05 considered statistically significant (Chi-square test)

As shown in the pie chart, pneumonia was present in approximately two-fifths, 38 (40.9%) of the participants, highlighting a substantial burden of respiratory complications in children with cerebral palsy. The remaining 55 (59.1%) did not have pneumonia (Figure 1).

Distribution of Pneumonia Among Children with Cerebral Palsy

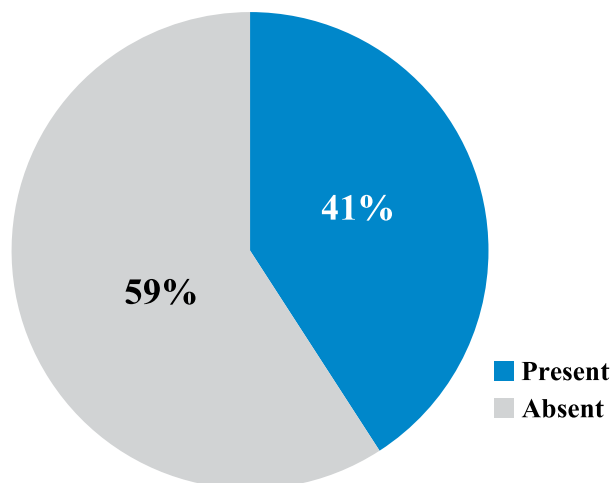


Figure 1: Distribution of Pneumonia among Children with CP (n=93)

DISCUSSION

Cerebral palsy (CP) is a neurodevelopmental condition often accompanied by multiple comorbidities, with pneumonia being one of the most frequent and life-threatening complications. In our study, the prevalence of pneumonia among children with CP was 40.9%, which aligns closely with the findings of Whitney *et al.* who reported recurrent pneumonia in 41% of children with severe motor dysfunction [9]. This high burden reflects the multifactorial vulnerabilities in this population, including impaired swallowing, poor airway clearance, and limited

mobility. Our study found that aspiration history had the strongest association with pneumonia ($p < 0.001$), which is consistent with several previous studies. Mody *et al.* demonstrated that aspiration pneumonia was a leading cause of hospitalization in children with spastic quadriplegia [10]. Similarly, a study by Kopyka *et al.* identified oropharyngeal dysphagia as a key risk factor for respiratory infections in CP children [11]. This highlights the mechanism by which aspiration contributes to pneumonia: impaired swallowing leads to misdirection of food or saliva into the airway, while reduced cough reflex prevents clearance, resulting in recurrent lower respiratory tract infections. These findings reinforce the critical role of early identification and management of swallowing dysfunction to prevent aspiration-related complications. The feeding method was another significant predictor in our study, where all pneumonia cases occurred in orally fed children, and none in those using nasogastric or PEG feeding. This result supports the idea that assisted feeding may reduce aspiration risk by bypassing dysfunctional swallowing, although it may also reflect closer monitoring and caregiver vigilance in children who require tube feeding. Previous studies have noted both benefits and risks associated with tube feeding. Aishauova *et al.* emphasized that while PEG feeding reduces aspiration in some cases, improper technique or reflux can still pose risks [12]. Nutritional status was also significantly associated with pneumonia. Surprisingly, all pneumonia cases were seen in children with normal nutritional status, while none of the severely malnourished children developed pneumonia. This counterintuitive finding may be explained by reduced exposure of severely malnourished children, who are often less mobile and more frequently hospitalized, thereby limiting contact with community-acquired pathogens. Alternatively, detection bias may have played a role, as severely malnourished children are more closely

monitored for nutritional complications than for respiratory illnesses. This contradicts findings by Peneva *et al.* who observed that malnourishment increases susceptibility to infections due to weakened immunity [13]. Another unusual observation was that all pneumonia cases occurred in immunized children ($p < 0.001$). While this finding appears contradictory to existing evidence, it may reflect confounding factors. Immunized children in our setting may be more active, socially exposed, or better documented, which increases the likelihood of pneumonia being diagnosed and recorded. Conversely, children with incomplete immunization may have lower healthcare access, resulting in underreporting. Most prior studies, including Amer *et al.* and Strzalkowski *et al.* confirm that incomplete immunization is a major risk factor for pneumonia in CP [14, 15]. Regarding the severity of CP, children with mild CP had the highest pneumonia frequency, while those with severe CP had none. This unexpected trend might be explained by differences in exposure: children with mild CP are more mobile, attend school or social gatherings, and therefore face greater exposure to pathogens, whereas children with severe CP remain mostly indoors and under constant supervision. Previous studies, such as Spoto *et al.* where severe CP was associated with increased risk due to poor cough reflex and limited mobility [16]. But our results suggest that social and environmental exposure may play a more significant role than severity alone in this context. Comparable findings were reported by Jonsson *et al.* who observed that pneumonia risk in CP may vary more with feeding and aspiration patterns than with gross motor function alone [17]. Furthermore, a study by Gordon *et al.* concluded that caregiver education and feeding practices greatly influenced respiratory outcomes, regardless of CP subtype or severity [18]. In Pakistan, local evidence remains limited, but studies highlight similar concerns. Rafique *et al.* reported respiratory complications in 38% of CP patients at a tertiary center in Karachi, while Qureshi *et al.* emphasized aspiration and poor feeding practices as major risk factors [19, 20]. Our findings are consistent with this regional data and underline the urgent need for structured feeding assessments, aspiration prevention protocols, and caregiver training programs in Pakistani hospitals. In summary, our study reinforces existing international and local evidence that pneumonia is a significant clinical concern in children with cerebral palsy, particularly in relation to aspiration, feeding method, and immunization. Unexpected findings such as the absence of pneumonia in severe CP and severely malnourished children highlight the importance of considering contextual factors like exposure risk, caregiver behavior, and healthcare access. These insights underscore the need for tailored preventive strategies.

This study was limited by its single-center, cross-sectional design and relatively small sample size, which may restrict generalizability and prevent causal inference. The reliance on clinical diagnosis and hospital-based sampling may also introduce detection bias. Future multicenter, longitudinal studies with larger cohorts and standardized diagnostic criteria are recommended to better clarify causal relationships and evaluate long-term respiratory outcomes. Incorporating objective swallowing assessments and follow-up data would further strengthen evidence for preventive interventions in children with cerebral palsy.

CONCLUSIONS

The present study identified a high frequency of pneumonia (40.9%) among children with cerebral palsy. Aspiration history, oral feeding, and immunization status were found to be strongly associated with the presence of pneumonia. Contrary to expectations, severe CP and malnutrition were not linked with increased pneumonia risk, which may point to confounding protective factors or limited exposure. These findings highlight the need for structured feeding assessments, aspiration prevention protocols, and continued caregiver education to mitigate respiratory complications in children with CP.

Authors' Contribution

Conceptualization: BH

Methodology: SP, SA, AF, AMK, AAQ

Formal analysis: BH, SP, SA, AF, AMK, AAQ

Writing and Drafting: BH, AAQ

Review and Editing: BH, AAQ, SP, SA, AF, AMK

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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