

PREVALENCE AND RISK FACTORS OF SEVERE PNEUMONIA AMONG CHILDREN AGED 2 - 60 MONTHS IN KON TUM PROVINCE, VIETNAM: A CROSS-SECTIONAL STUDY

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ABSTRACT

Objective: To identify clinical and epidemiological characteristics and associated factors of severe pneumonia in children aged 2-60 months at Kontum Provincial General Hospital, Vietnam.

Methods: This cross-sectional study included 370 children diagnosed with pneumonia between July 2023 and May 2024, along with their mothers. Data on demographics, clinical characteristics, laboratory findings, and pre-hospitalization care were collected. Pneumonia diagnosis and severity classification followed Vietnamese Ministry of Health 2014 criteria. Multivariate logistic regression identified factors independently associated with severe pneumonia.

Results: Among the cohort (mean age 13.16 ± 11.68 months), 55.7% were male and 75.4% belonged to ethnic minorities. The prevalence of severe pneumonia was 18.4%. Laboratory findings showed mean leukocyte count of $14,633.78 \pm 6,402.87$ cells/mm³, neutrophil percentage of $52.42 \pm 33.00\%$, and CRP levels of 18.50 ± 36.71 mg/L. Radiographic pulmonary lesions were present in 93.2% of cases. Multivariate analysis identified three independent risk factors for severe pneumonia: younger age (OR = 0.965, 95%CI: 0.935 - 0.996, $p = 0.029$), first-born status (OR = 1.846, 95%CI: 1.047 - 3.254, $p = 0.034$), and absence of pre-hospitalization medical care (OR = 2.027, 95%CI: 1.054 - 3.898, $p = 0.034$). While 77.3% of children experienced symptoms for ≥ 3 days before hospitalization, only 42.4% had complete age-appropriate immunizations.

Conclusion: The prevalence of severe pneumonia in this predominantly ethnic minority population reflects Vietnam's ongoing epidemiological transition. Younger age, first-born status, and lack of pre-hospitalization care significantly increase severe pneumonia risk. These findings highlight the importance of enhanced community-based health education for first-time parents, strengthened primary healthcare capacity, and improved immunization coverage to reduce pneumonia severity in this vulnerable population.

Keywords: Severe pneumonia; pediatric; risk factors; ethnic minorities; Vietnam.

I. INTRODUCTION

Pneumonia remains a significant global health challenge, contributing substantially to respiratory mortality in the pediatric population under five years of age worldwide. This condition accounts for approximately 15-18% of total mortality in this vulnerable age group, with a particularly devastating impact in developing countries where an estimated 700,000 children succumbed to the disease in 2022, according to UNICEF data [1]. The etiology of

pneumonia demonstrates geographical variation, with viral pathogens predominating in developed nations, while bacterial agents constitute the most causative organisms in developing regions. Key modifiable pneumonia risk factors are suboptimal breastfeeding, poor nutrition, air pollution, low birth weight, and incomplete immunization coverage [2]. Severe cases often result in complications, longer hospitalizations, and higher treatment costs, particularly impacting vulnerable socioeconomically disadvantaged groups.

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Pediatric pneumonia is a major public health issue in Vietnam, causing approximately 4,000 deaths annually in children under 5 years old [3]. Kon Tum province, with its large ethnic minority population (over 70%) and socio-economic constraints, faces significant challenges in pediatric healthcare delivery, including access barriers and cultural factors.

Despite the magnitude of this issue, there exists a notable paucity of region-specific research examining the determinants and clinical characteristics of pneumonia, particularly severe manifestations, within this unique population. Previous studies from other provinces in Vietnam have reported varying prevalence rates of severe pneumonia, ranging from 33.6% to 78.2% [3], but these findings may not be generalizable to Kon Tum's distinctive demographic and socioeconomic profile. The identification of locality-specific pneumonia characteristics and associated risk factors constitutes an essential prerequisite for enhancing preventive strategies, optimizing diagnostic approaches, improving therapeutic interventions, and refining prognostic assessments.

This study was designed with dual objectives: to comprehensively characterize the clinical and epidemiological features of pneumonia in pediatric patients aged 2 to 60 months presenting to the Pediatric Department of Kon Tum Provincial General Hospital, and to ascertain the prevalence of severe pneumonia while elucidating factors significantly associated with disease severity within this population. The findings will contribute to evidence-based interventions for reducing the burden of severe pneumonia among affected children and their families in this resource-constrained setting, with potential implications for similarly situated regions throughout Vietnam and Southeast Asia.

II. MATERIALS AND METHODS

2.1. Research method

This cross-sectional, descriptive study examined mother-child pair (children aged 2-60 months diagnosed with pneumonia or severe pneumonia) at Kon Tum Provincial General Hospital's Pediatrics Department between July 2023 and May 2024, using medical records. Inclusion criteria were children

aged 2-60 months diagnosed with pneumonia or severe pneumonia upon admission whose primary caregiver (mother) provided informed consent, while exclusion criteria included pre-existing chronic respiratory conditions (e.g., asthma, cystic fibrosis), known immunodeficiency, or having a non-maternal primary caregiver or lack of consent. Pneumonia diagnosis and severity classification were primarily based on clinical presentations, using the Vietnamese Ministry of Health's 2014 criteria [4].

2.2. Sample size

The sample size was calculated using the formula for determining a proportion in a population:

$$n = Z_{1-\alpha/2}^2 \times \frac{p(1-p)}{d^2}$$

where $Z_{1-\alpha/2} = 1.96$ with a statistical significance level of 95%, $p = 0.336$ representing the proportion of severe pneumonia among pneumonia cases in children aged 2-60 months from a 2020 study at Quang Ngai Provincial Obstetrics and Pediatrics Hospital by Nguyen, Nguyen and Vo (2021) [5], and $d = 0.05$ as the chosen absolute error. The calculated minimum sample size was 343, while the actual study enrolled 370 mother-child pairs who met the criteria and consented to participate.

2.3. Variables

The independent variables were categorized into four main groups:

- Characteristics of children (age, gender, ethnicity, economic conditions, tobacco smoke exposure, hospitalization duration) and mothers (age, education level, occupation).
- Birth history, nurturing practices, and medical history (birth weight, prematurity, delivery method, breastfeeding patterns, complementary feeding, immunization status, and recent illnesses).
- Clinical features at admission include general danger signs, respiratory symptoms, pneumonia severity, and nutritional status (assessed via z-scores).
- Laboratory findings include complete blood count, C-reactive protein (CRP) levels, and chest radiographic findings. The dependent variable was the child's pneumonia status, classified as either pneumonia or severe pneumonia.

2.3. Pneumonia and severe pneumonia definition

Pneumonia was defined as cough and fever accompanied by at least one of the following signs: tachypnea (respiratory rate > 50 breaths/minute for ages 2-12 months or > 40 breaths/minute for ages 12-60 months), chest indrawing, or abnormal breath sounds including decreased ventilation, moist rales, crackles, bronchial rales, or localized decreased ventilation. Severe pneumonia was diagnosed when a child exhibited pneumonia signs plus at least one severe systemic sign (inability to feed or drink, altered consciousness including lethargy or coma, or convulsions) or severe respiratory distress (grunting, severe chest indrawing, cyanosis or SpO₂ < 90%, or age under 2 months). Diagnostic imaging typically revealed diffuse opacities with unclear borders across both lungs and systematic opacities containing air bronchograms, with atypical pneumonia potentially showing diverse lesions. Laboratory findings often showed elevated peripheral white blood cell count, neutrophils, and CRP in bacterial pneumonia, while these parameters remained normal in viral or atypical bacterial pneumonia.

2.4. Data analysis

Analyzed in SPSS 20.0. Descriptive statistics: frequencies/percentages (categorical), means/SD or medians/range (continuous). Group comparisons: chi-square/Fisher's, t-tests. Logistic regression: independent predictors of severe pneumonia (univariate $p < 0.05$ inclusion). Statistical significance for all tests was set at $p < 0.05$.

2.5. Research ethic

The study adhered to ethical regulations and received approval from the Ethics Committee of Hue University of Medicine and Pharmacy (No: H2023/339, dated June 2, 2023) and permission from the Board of Directors of Kon Tum Provincial General Hospital. The mothers of pediatric patients were informed, consented to participate, and their personal information was kept confidential.

III. RESULTS

Analysis of the demographic profile revealed that among 370 pediatric pneumonia patients, 55.7% ($n = 206$) were male and 44.3% ($n = 164$) were female. The ethnic distribution demonstrated a predominance of ethnic minority children,

constituting 75.4% ($n = 279$) of cases, while Kinh ethnicity represented 24.6% ($n = 91$). The mean age of the study population was 13.16 ± 11.68 months (range: 2-60 months), with corresponding anthropometric measurements showing a mean weight of 7.81 ± 3.27 kg (range: 2.0 - 24.5 kg) and mean height of 67.94 ± 11.83 cm (range: 33 - 108 cm). These demographic characteristics are summarized in Table 1.

Table 1: Demographic characteristics of study participants ($n = 370$)

Characteristics	n (%) or Mean $\pm$ SD	Min -max
Gender		
Female	164 (44.3)	-
Male	206 (55.7)	-
Ethnicity		
Kinh	91 (24.6)	-
Ethnic minorities	279 (75.4)	-
Age (months)	13.16 ± 11.68	2 - 60
Weight (kg)	7.81 ± 3.27	2.0 - 24.5
Height (cm)	67.94 ± 11.83	33 - 108

Examination of birth history and early-life factors revealed that 19.2% ($n = 71$) of children had a history of low birth weight, while 14.6% ($n = 54$) were born prematurely. Birth order analysis indicated that 69.2% ($n = 256$) were first-born children. Early nutritional practices showed that 85.1% ($n = 315$) of infants received early breastfeeding within the first hour after birth, with mean breastfeeding duration of 14.07 ± 5.86 months. Notably, immunization coverage assessment demonstrated substantial gaps, with only 42.4% ($n = 157$) of children receiving complete and age-appropriate vaccinations, 6.2% ($n = 23$) having complete but delayed immunizations, and 51.4% ($n = 190$) exhibiting incomplete vaccination schedules. Table 2 presents the distribution of birth history, nutrition, and immunization status factors.

Table 2: Birth history, nutrition, and immunization status of study subjects (n=370)

Characteristics	n	%
History of Low Birth Weight		
No	299	80.8
Yes	71	19.2
History of Prematurity		
No	316	85.4
Yes	54	14.6
Birth Order		
First child	256	69.2
Subsequent child	114	30.8
Early Breastfeeding (within 1 hour after birth)		
Yes	315	85.1
No/Don't remember	55	14.9
Immunization Status		
Complete and age-appropriate	157	42.4
Complete but not age-appropriate	23	6.2
Incomplete	190	51.4

Analysis of the interval between symptom onset and hospital presentation revealed that 77.3% (n = 286) of children experienced symptoms for three or more days prior to hospitalization, while only 22.7% (n = 84) were presented within the first three days of illness onset. Assessment of pre-hospitalization management pathways showed that 78.9% (n = 292) had received appropriate primary healthcare

interventions, having been evaluated by primary care physicians who initiated treatment and subsequently referred them to higher-level care. Conversely, 19.7% (n = 73) of children received no specific medical care prior to hospital presentation, while 1.4% (n = 5) underwent self-medication without professional consultation. These pre-hospitalization characteristics are presented in Table 3.

Table 3: Duration of illness prior to admission and pre-hospitalization care (n = 370)

Characteristics	n	%
Time from symptom onset to admission		
< 3 days	84	22.7
≥ 3 days	286	77.3
Pre-hospitalization care		
No specific care	73	19.7
Self-medication	5	1.4
Consultation with primary care physician with treatment and referral	292	78.9

Hematological analysis yielded a mean leukocyte count of $14,633.78 \pm 6,402.87$ cells/mm³ (range: 1,100 - 52,500 cells/mm³), with a mean neutrophil percentage of $52.42 \pm 33.00\%$ (range: 6.6 - 57.73%). C-reactive protein (CRP) measurements demonstrated a mean concentration of 18.50 ± 36.71 mg/L (range: 0 - 301.2 mg/L). Radiographic evaluation showed pulmonary lesions consistent with pneumonia in 93.2% of cases, while 6.8% (n = 25) exhibited normal radiographic findings despite clinical pneumonia diagnosis. Table 4 summarizes these laboratory and radiographic findings.

Table 4: Laboratory and radiographic findings in study participants (n=370)

Parameters	n (%) or Mean $\pm$ SD (Range)
Total White Blood Cell Count (cells/mm ³)	$14,633.78 \pm 6,402.87$ (1,100 - 52,500)
Neutrophil Percentage (%)	52.42 ± 33.00 (6.6 - 57.7)
C-Reactive Protein (mg/L)	18.50 ± 36.71 (0 - 301.2)
Radiographic Pulmonary Lesions	
Present	345 (93.2)
Absent	25 (6.8)

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Among the 370 children diagnosed with pneumonia, 18.4% (n = 68) presented with severe pneumonia, while 81.6% (n = 302) exhibited non-severe manifestations. To identify factors independently associated with severe pneumonia, a multivariate logistic regression model was constructed, incorporating variables that demonstrated statistical significance in univariate analysis.

The multivariate analysis revealed three independent predictors of severe pneumonia: (1) younger age (OR = 0.965, 95% CI: 0.935 - 0.996, p = 0.029), indicating that for each one-month increase in age, the odds of developing severe pneumonia decreased by 3.5%; (2) birth order, with first-born children exhibiting nearly twice the odds of developing severe pneumonia compared to subsequent children (OR = 1.846, 95% CI: 1.047 - 3.254, p = 0.034); and (3) absence of pre-hospitalization medical care (OR = 2.027, 95% CI: 1.054 - 3.898, p = 0.034) compared to children who received primary care consultation with treatment and referral. Table 5 presents the complete results of the multivariate logistic regression analysis.

Table 5: Multivariate logistic regression model for factors associated with severe pneumonia in children (n=370)

Independent variables	OR	95% CI	p-value
Age of child	0.965	0.935 - 0.996	0.029
Ethnicity			
Ethnic minorities (ref)	1		
Kinh	1.86	0.879 - 3.945	0.645
Birth order			
Subsequent child (ref)	1		
First child	1.846	1.047 - 3.254	0.034
Early breastfeeding within 1 hour			
No/Don't remember (ref)	1		
Yes	0.587	0.287 - 1.201	0.145
Time from symptom onset to admission			
< 3 days (ref)	1		
≥ 3 days	0.779	0.410 - 1.48	0.446
Pre-hospitalization care			
Primary care consultation with treatment and referral (ref)	1		
No specific care	2.027	1.054 - 3.898	0.034
Self-medication	4.220	0.668 - 26.664	0.126

Although ethnicity (Kinh vs. ethnic minorities), early breastfeeding practices, and time from symptom onset to admission were included in the model, these variables did not demonstrate statistically significant associations with pneumonia severity in this population. Self-medication showed a trend toward increased severity risk (OR = 4.220, 95% CI: 0.668 - 26.664) but did not reach statistical

significance (p = 0.126), possibly due to the small number of cases in this category.

IV. DISCUSSION

In our cross-sectional study conducted in Kon Tum province, we observed a prevalence of severe pneumonia of 18.4% among 370 hospitalized pediatric pneumonia cases. This finding represents an intermediate position when compared with both

domestic and international studies. Our prevalence is notably lower than previous Vietnamese studies, including the 33.6% reported by Nguyen, Nguyen and Vo (2021) in Quang Ngai province [5]. Conversely, our prevalence exceeds international benchmarks such as the 13% reported by Onyango et al. (2012) in Kenyan children aged 2-59 months and the 7 - 13% range identified by Rudan et al. (2008) among pediatric populations in Arab nations requiring hospitalization for severe pneumonia [6, 7].

This comparatively moderate prevalence likely reflects Vietnam's ongoing epidemiological transition in childhood pneumonia burden. The Global Burden of Disease studies have documented substantial declines in pneumonia incidence, severity, and mortality across low- and middle-income countries, with particularly accelerated reductions in East and Southeast Asia. During the 2005 - 2015 period, under-5 mortality decreased by 37% globally, with the most rapid declines (> 50%) in pneumonia-related mortality observed in East and Southeast Asia, Central Europe, and tropical Latin America [8]. Several factors likely contribute to this trend, including expanded immunization coverage against principal pneumonia pathogens (*Streptococcus pneumoniae* and *Haemophilus influenzae*), enhanced early detection and treatment protocols, and improved community-based health education initiatives [1].

Multivariate logistic regression analysis identified three independent predictors of severe pneumonia in our population. Age emerged as a critical determinant, with each additional month conferring a protective effect (OR = 0.965, 95% CI: 0.935 - 0.996). This age-dependent vulnerability corroborates findings from previous domestic studies, including Luu and Khong (2019), who reported similar protective effects with increasing age [9]. The enhanced susceptibility of younger children likely reflects the developmental immaturity of respiratory structures and immunological systems. As Luu and Khong (2019) describe, infant lungs possess increased vascularity and lymphatic presence but reduced elastic tissue, while exhibiting incompletely developed immune responses, predisposing to both heightened infection susceptibility and accelerated clinical deterioration [9].

This age-related vulnerability pattern aligns with extensive international literature. Shan et al. (2019) demonstrated that children below 24 months exhibited 1.59 - 1.96 times higher risk of severe pneumonia compared to those aged 24 - 60 months. Similarly, research from India has documented significantly higher hospitalization rates for severe pneumonia among younger children [10]. Ibraheem et al. (2018) observed higher pneumonia rates among infants and toddlers under two years in Nigeria, while Wu et al. (2022) attributed the diminished respiratory infection risk with advancing age to the progressive maturation of sinusal structures and immune function [11, 12].

Birth order demonstrated significant association with pneumonia severity in our study, with first-born children exhibiting 1.846 times (95% CI: 1.047 - 3.254) higher odds of developing severe disease compared to subsequent children. This relationship likely reflects parental experiential knowledge deficits regarding recognition of respiratory warning signs and appropriate care-seeking behaviors. Azab et al. (2014) established that maternal deficits in maternal-child healthcare knowledge increased severe pneumonia risk (OR = 3.8, 95% CI: 2.12-6.70) in Egyptian children [13].

While ethnicity demonstrated significance in univariate analysis, with ethnic minority children showing higher severe pneumonia rates compared to Kinh children, this association did not persist in multivariate modeling. Nevertheless, this preliminary finding merits consideration within the sociocultural context of Kon Tum province. Additionally, infrastructure limitations and healthcare access disparities in remote areas predominantly inhabited by ethnic minorities likely influence pneumonia outcomes, paralleling Azab et al.'s (2014) findings regarding the relationship between healthcare resource constraints and increased severe pneumonia risk [13].

The demonstrated importance of pre-hospitalization care observed in our study offers valuable insights into comparable healthcare systems with developing primary care networks. Similar to Vietnam's experience, many countries in the region are undergoing epidemiological transitions where pneumonia burden is decreasing

but remains disproportionately concentrated in disadvantaged communities. Our findings suggest that strengthening primary healthcare capacity and community-based education may yield substantial benefits in reducing severe pneumonia prevalence in these comparable settings.

Pre-hospitalization care emerged as the third significant predictor of pneumonia severity, with children lacking specific medical attention before admission demonstrating 2.027 times (95% CI: 1.054 - 3.898) higher odds of severe pneumonia compared to those receiving appropriate primary care evaluation, treatment, and referral. This finding underscores the critical importance of timely nutritional support, adequate hydration, and formal medical consultation in mitigating disease progression. Children with pneumonia require enhanced nutrition through easily digestible, liquid-form foods and increased fluid intake to maintain energy levels, alongside prompt medical evaluation and appropriate referral when necessary.

Our findings regarding pre-hospitalization care align with those Phua et al. (2016) identified malnutrition as a significant risk factor, with nutritionally compromised children exhibiting 3.27 times higher risk of severe pneumonia compared to well-nourished counterparts [14].

Our finding that only 42.4% of children had complete and age-appropriate immunizations highlights a significant preventive gap that requires urgent attention. Expansion of immunization coverage against principal pneumonia pathogens, particularly in remote areas with challenging access to healthcare services, should focus on complete vaccination schedules rather than partial coverage. Enhancement of referral systems between community healthcare facilities and higher-level hospitals would facilitate timely intervention for children with evolving pneumonia, particularly addressing transportation challenges in remote areas.

V. CONCLUSION

The prevalence of severe pneumonia (18.4%) among children aged 2 - 60 months in Kon Tum reflects Vietnam's transitional epidemiological profile. Younger age, first-born status, and absence of pre-hospitalization care were identified as independent predictors of disease severity,

highlighting both biological and healthcare access vulnerabilities. Strengthening primary healthcare capacity, improving parental education - especially for first-time parents - and expanding immunization coverage are essential to reduce severe pneumonia burden. These findings support community-based, culturally sensitive interventions and provide direction for future longitudinal research to assess causal pathways and intervention effectiveness.

Declaration of conflicting interests

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article

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