

Mortality Rate and Its Risk Factors among Children under 5 Years Admitted at University Teaching Hospital of Butare

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How to cite this paper: Daniel, M., Kasine, R.K., Rose, N., Eugenie, N., Leonie, N., Victoire, U.D., Calmeline, T., Virginie, N., Winifride, M. and Josiane, U. (2026) Mortality Rate and Its Risk Factors among Children under 5 Years Admitted at University Teaching Hospital of Butare. *Open Journal of Nursing*, 16, 618-637.

<https://doi.org/10.4236/ojn.2026.1610043>

Received: July 6, 2026

Accepted: October 24, 2026

Published: October 27, 2026

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Abstract

Introduction: Pneumonia is an infection that inflames the air sacs in one or both lungs, which may fill with fluid or pus. Pneumonia is a common and life-threatening condition that affects the lower airways; its severity is marked by a high mortality rate (1/1000 of affected patients). Recent studies have shown that pneumonia caused 740,180 deaths in children younger than 5 years of age worldwide in 2019, accounting for approximately 14% of under-5 deaths. Therefore, there is a need to determine the mortality rate and its risk factors among children with pneumonia at the University Teaching Hospital of Butare. **Methods:** A retrospective cross-sectional study of children's files with pneumonia admitted from July 2020 to June 2024 was conducted, using a pre-determined data collection form. Descriptive statistics were used to show frequency distribution for categorical variables. Chi-square and multivariate analysis were used to determine the independent factors associated with mortality while simultaneously controlling for potential confounders. A P-value of <0.05 was calculated and considered statistically significant. **Results:** The present study enrolled 206 children with pneumonia and found that 51.9% and 67.5% of participants were aged less than one year and female, respectively. The result showed that the mortality rate among the children with pneumonia was 13.1%. Multivariate analysis showed that the under five children who experi-

enced cyanosis (AOR = 8.11, 95% CI [1.00 - 10.30]) $P < 0.001$, CXR consolidation (AOR = 4.60, 95% CI [2.15 - 9.81] $P < 0.001$ and hyperleukocytosis (AOR = 10.80 95% CI [5.37 - 19.56] $P < 0.001$,) are the risk factors of mortality.

Conclusion: The hospital mortality rate was 13.1%, with mortality associated with cyanosis, CXR consolidation, and hyperleukocytosis on admission.

Keywords

Pneumonia, Mortality Rate, Risk Factors

1. Introduction

1.1. Background

Pneumonia refers to acute respiratory infections that assault the lungs and cause the alveoli to fill with pus and fluid, making breathing difficult and limiting oxygen intake. It can cause mild to severe illness in persons of all ages, but it is the leading infectious cause of mortality in children under five globally [1].

In the study done by McAllister *et al.*, the results showed that between 2000 and 2015, there was a significant decrease in the incidence and mortality of clinical pneumonia in under-five children worldwide; however, the mortality rate among the under-five children admitted for pneumonia varies between 1% and 20% depending on access to healthcare and effective management. In lower-income countries, the mortality rate tends to be higher, than that of higher-income countries. A study conducted in China, has reported the case fatality of 7.2% in rural areas and 1.7% in urban regions [2].

Different factors were reported to influence the mortality rate from pneumonia, among under-five children; the most common are malnutrition, coexisting pathologies like asthma, congenital heart disease, or HIV/AIDS [3]. In addition, mortality from pneumonia was associated with limited access to quality healthcare services, low rates of vaccination against pneumonia-causing pathogens (e.g., pneumococcus, *Hemophilus influenzae* type b) [4].

Poor living conditions, including overcrowding, exposure to indoor air pollution (e.g., smoke from cooking), and lack of clean water, can contribute to the severity of respiratory infections and poor outcomes. Researchers highlight the complex interplay between health, environment, and access to care in influencing the outcomes of pneumonia in young children [5].

1.2. Problem Statement

Pneumonia remains a global burden and the leading cause of death in children under 5 years, according to the Global Burden of Disease. Pneumonia kills 672,000 children each year; this means that one under-five child dies from pneumonia every 47 seconds [6].

Among under-five children, pneumonia remains a major cause of mortality

globally. High income and low income and countries are all affected with most deaths occurring in sub-Saharan Africa and South Asia. Pneumonia is among the top ten killers worldwide and causes 16% of child deaths globally [6]. In addition, UNICEF reported that pneumonia, as the number one killer among infectious diseases, accounts for 16% of deaths among children under five years. Pneumonia deaths in children under five reached 920,136 deaths, with over 70% of this mortality occurring in sub-Saharan Africa and East and South Asia.

Children in low-income countries are nearly 18 times more likely to die before the age of five than children in high-income countries, due mainly to pneumonia and other acute infections. In the last decade, global pneumonia was responsible for 1.6 million deaths per year among children under 5 years.

In a study conducted in the USA to assess the community acquired pneumonia requiring hospitalization, 69% of children were eligible, 89% of them had radiographic evidence of pneumonia, 21% required admission to intensive care, and <1% died from pneumonia [7].

In a study conducted in France, 22.8% of the under-five children admitted to the ICU for pneumonia died during hospitalization, while early antibiotic therapy was associated with an improved prognosis, particularly for VAP. ICU-hospital-acquired pneumonia, and mortality was higher among the under-five children suffering from pneumonia due to *P. aeruginosa* [8].

The mortality rate from pneumonia deaths in under-five children decreased from 1.7 million in 2000 to 0.9 million in 2015, and in 2015, 49% of global pneumonia deaths occurred in India, Nigeria, Pakistan, Democratic Republic of the Congo, and Ethiopia collectively. The key risk factors for child pneumonia were non-exclusive breastfeeding, crowding, malnutrition, indoor air pollution, incomplete immunization, and paediatric HIV [6].

A study conducted in Nigeria, has reported an overall mortality of 8.62% among the under-five children admitted for pneumonia; delayed hospital referral, incomplete immunization, severe malnutrition, refusal to feed and hypoglycemia were reported to significantly contribute to this high mortality among under-five children [9].

It was reported that pneumonia among under five years children is an important public health problem, the knowledge about the disease and its treatment is inadequate among both health workers and mothers, and low birth weight and limited access to health facility contribute to high mortality from pneumonia among under five years children; 81% of health care providers suggested the pneumonia as one of the top five causes of morbidity, and 88% highlighted pneumonia as one of the top five causes of mortality [5].

Various studies have found that pneumonia was the leading cause of death in under-five children and contributed to 25.7% of total deaths. Mortality from pneumonia among under-fives was higher from April to June; this period corresponds to the rainy season and, of course, the cold season [10].

Furthermore, a study conducted on the main causes of under-five death in Tan-

zania found that pneumonia contributed to 22% of all under-five mortalities [4].

The mortality rate among under-five children admitted for pneumonia was reported to be 15.5%; the main predictor of poor outcome was the severity of pneumonia, hypoxemia and severe malnutrition; *S. aureus*, *S. pneumonia* and *H. influenza* are common bacterial causes of severe pneumonia, and those microorganisms were associated with poor prognosis, among under-fives suffering from pneumonia [3].

In Rwanda, the study conducted at Kabutare District Hospital showed that In-hospital death cases due to pneumonia amounted to 72 prior to PCV-7 introduction versus 30 post-PCV-7 introduction. Statistical analyses showed a 53% reduction in child hospitalization due to pneumonia between the two periods [11].

In 2022, Rwanda's under-five mortality rate was reported at 38 deaths per 1000 live births. While specific recent data attributing under-five deaths directly to pneumonia in Rwanda is limited, globally, pneumonia accounts for approximately 18% of all deaths in children under five [12].

Efforts to combat pneumonia in Rwanda have included implementing vaccines, such as the pneumococcal conjugate vaccine (PCV), to reduce pneumonia-related morbidity and mortality in children under five. Despite these interventions, pneumonia continues to pose a threat to child health in Rwanda. Continued focus on preventive measures, timely treatment, and comprehensive healthcare strategies is essential to further reduce its impact.

1.3. Objective of the Study

1.3.1. General Objective

The purpose of this study was to determine the mortality rate and the contributing factors among under-five-year-old children admitted for pneumonia at University Teaching Hospital of Butare (CHUB).

1.3.2. Specific Objectives

- 1) To determine the mortality rate among under-five children admitted for pneumonia at University Teaching Hospital of Butare (CHUB).
- 2) To identify factors associated with mortality among under-five children admitted for pneumonia at University Teaching Hospital of Butare (CHUB).

1.4. Research Questions

- 1) What is the mortality rate among under-five children admitted for pneumonia at University Teaching Hospital of Butare (CHUB)?
- 2) What are the factors associated with mortality among under-five children admitted for pneumonia at University Teaching Hospital of Butare (CHUB)?

1.5. Justification and Significance of the Study

1.5.1. Personal Interest

These research findings will be beneficial to nurses working in the pediatric department in terms of improving awareness of risk factors associated with the mor-

tality of under-five children affected by pneumonia. This will play a big role in prevention and management of pneumonia.

1.5.2. Academic Interest

Researchers will use the findings as baseline information for further research and as a literature source on risk factors associated with mortality from pneumonia among children under five years old.

1.5.3. Social Interest

The results of this study will inform decision-makers and policymakers about factors associated with mortality among children under five, and they may use them to design suitable policies, procedures, and strategies to address pneumonia among children under five years old.

1.6. Scope of the Study

1.6.1. Scope in Domain

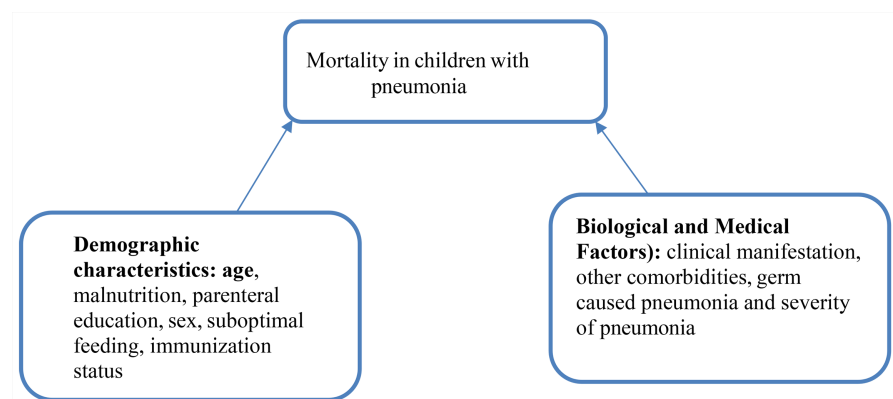
This study focused on determining the mortality rate and contributing factors among children under five admitted for pneumonia.

1.6.2. Scope in Space

University Teaching Hospital of Butare (CHUB) is located in Southern Province, Huye District, Ngoma Sector, Butare Cell, and Mamba Village, Hospital Road, Huye, and is located 130 km from Kigali, the capital of Rwanda. The study focused on pediatric hospitalization.

1.7. Conceptual Framework

This conceptual framework displays factors that influence the occurrence of death among children with pneumonia. It shows how both demographic characteristics and clinical factors are associated with mortality among children under five years.



2. Research Methodology

This third chapter describes how the study was conducted. The following are listed in the order that they were considered: study area/site description, research design, target population, sampling techniques, methods and techniques of data col-

lection, data analysis procedures, and ethical considerations.

2.1. Study Area Description

The study was conducted at the University Teaching Hospital of Butare, located in HUYE District, Southern Province. It is a university teaching hospital with 37 pediatric beds. CHUB started its health services in 1928. At that time, it was the Butare Hospital. It was built by Belgian colonists. Butare Hospital became a University Teaching Hospital in 1966. CHUB now has eight clinical departments: Surgical Department, Pediatric Department, Accident and Emergency Department, Ambulatory Care Department, Medical Department, Obstetrics and Gynecology Department, Anesthesiology and Critical Care Department, and Mental Health Department.

2.2. Research Design

The researcher used a retrospective cross-sectional study design using a quantitative method to review the files of children admitted from July 2020 up to June 2024. The study aimed to identify risk factors and determine the mortality rate of pneumonia among under-five children at the University Teaching Hospital of Butare (CHUB).

2.3. Target Population and Eligibility Criteria

The study population for a survey comprised children younger than five years admitted with pneumonia to pediatric department of CHUB between July 2020 and June 2024. A total of 298 potentially eligible records were identified from the pediatric hospitalization register. Records were included if the child was younger than five years at admission, pneumonia was documented as a diagnosis, the admission occurred within the study period, and sufficient information was available to determine the hospitalization outcome. Records were excluded if the child did not meet the age or diagnostic criteria, the record was duplicated or unavailable, or essential information required to determine the primary outcome was missing.

2.4. Sampling Techniques

A census sampling of all children's files admitted in the pediatric unit of CHUB from July 2020 up to June 2024 was used. A census includes all subjects in the total population as the research sample. This technique was used because of the low number of children with pneumonia per year.

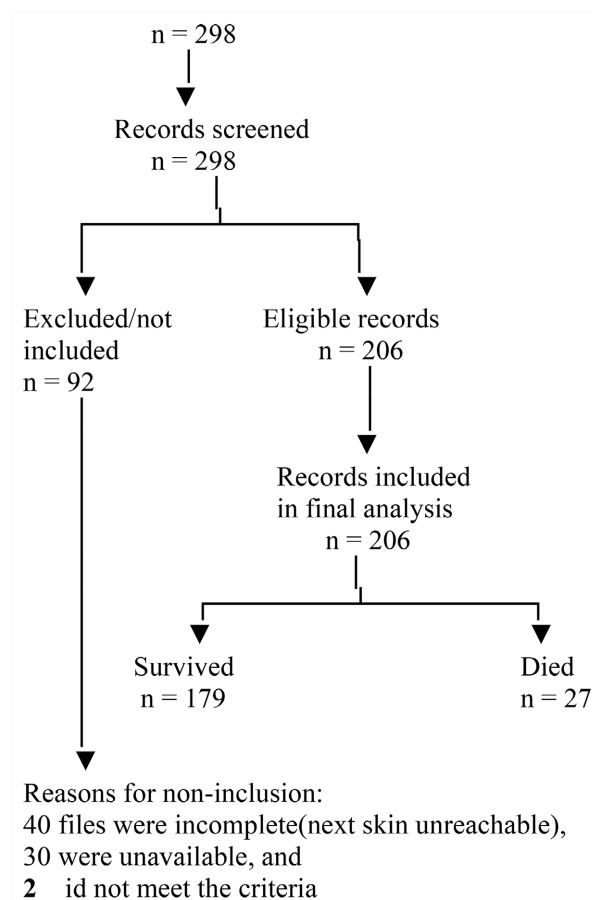
2.5. Sample Size and Power Rationale

Because a census of all 298 eligible records during the study period was attempted, no prospective sample-size calculation was used to determine recruitment. The final analytic sample comprised 206 records, including 27 deaths (13.1%). As an approximate assessment of precision and detectable effect, this sample yields a

95% confidence interval of about 8.5% - 17.7% for the observed mortality proportion (approximately ± 4.6 percentage points). Assuming a two-sided $\alpha = 0.05$, 80% power, and a reference mortality of 10%, the sample would detect an absolute difference of approximately 5.9 percentage points (about 15.9% versus 10%) under a normal approximation. This post hoc calculation describes the information available from the census rather than serving as an a priori sample-size determination.

After screening and assessing record completeness, 92 records were excluded. Thus, 69.1% of the initially identified records were analyzed. The study flow diagram below documents the reasons for excluding these 92 records.

Records identified from pediatric hospitalization register, July 2020 - June 2024



2.6. Methods and Techniques of Data Collection

A predetermined questionnaire composed of four parts was used to collect data (see **Appendix**). Part one covers demographic characteristics of the parent and the child, including occupation, child age, child sex, immunization status, socioeconomic status, parental education, and breastfeeding status. The second part covers clinical signs and comorbidities, including GCS at admission, oxygenation status, pneumonia severity, respiratory signs and symptoms, malnutrition, and the most prevalent comorbidities in children. The third part covers the clinical investigation and etiology, including the germ identified as the cause of pneumo-

nia, chest X-ray characteristics, and white blood cell count. The fourth part of the outcome includes the length of stay in hospital and survival status. Where information was missing from the medical record, the parent or next of kin was contacted to obtain verbal consent and, when feasible, the needed information. The number of caregivers contacted was not systematically recorded.

2.7. Data Analysis Procedures

Data were collected using a predetermined tool and cleaned, coded into an Excel sheet, and then exported into SPSS version 23 for analysis. Descriptive statistics were used to show frequency distributions for categorical variables and to calculate the mean and standard deviation for continuous variables. Univariate analysis was used to identify all possible factors to be included in multivariate analysis if their P-value is less than 0.25. Multivariate logistic regression analysis was used to determine the independent factors associated with mortality while simultaneously controlling for potential confounders. A P-value of <0.05 was considered statistically significant.

2.8. Ethical Consideration

The ethical approval for this study was obtained from the University of Gitwe Institutional Review Board (UGIRB), approval number UG IRB/2025/PROP/21, and research ethics approval was obtained from the Research Ethics Committee of University Teaching Hospital of Butare (CHUB), approval number REC/CHUB/011/2025. The approvals authorized the review of eligible pediatric records and the conduct of the study at CHUB.

The unit pediatric manager granted permission to access the pediatric hospitalization register and medical records. The study maintained patient confidentiality and anonymity throughout. The analytical dataset and research reports did not include identifying information, and the collected information was used exclusively for research purposes.

Because the study involved retrospective review of medical records, information was primarily obtained from existing patient files. When it was necessary to contact a parent or next of kin to obtain information missing from the medical record, the purpose of the contact was explained and verbal informed consent was obtained before collecting any additional information. Participation in the telephone contact was voluntary, and no caregiver information was collected without consent. The study followed the ethical requirements specified by the approving institutions.

3. Results

3.1. Presentation of Data

3.1.1. Socio-Demographic Characteristics of Participants

Table 1 illustrates the socio-demographic characteristics of participants in terms of frequencies and percentages according to their categories.

Table 1. Socio-demographic characteristics of participants.

Variable		Number	Percent
Age	0 - 1 year	107.00	51.90
	>1 - 5 years	99.00	48.05
Sex	Male	67.00	32.50
	Female	139.00	67.50
Mother's education	No formal education	86.00	41.70
	Primary	56.00	27.20
	Secondary	30.00	14.60
	University	34.00	16.50
Immunization	No	5.00	2.50
	Yes	201.00	97.50

3.1.2. Medical Data of Children under 5 Years Admitted for Pneumonia

Table 2 illustrates the demographic and medical characteristics of children under 5 years admitted for pneumonia in terms of frequencies and percentages according to their categories.

Table 2. Medical characteristics of children under 5 years admitted for pneumonia.

Variables		Number	Percent
Decreased level of consciousness	Yes	57.00	27.70
	No	149.00	72.30
Wheezing	No	153.00	74.60
	Yes	85.00	41.10
Severe pneumonia	No	86.00	41.70
	Yes	120.00	58.30
Cyanosis	No	121.00	58.70
	Yes	85.00	41.30
Tachycardia	No	45.00	21.80
	Yes	161.00	78.20
Tachypnea	No	32.00	15.50
	Yes	174.00	84.50
Convulsions	No	163.00	79.10
	Yes	43.00	20.90
Chest indrawing	No	75.00	36.40
	Yes	131.00	63.60
Anemia	No	122.00	59.20
	Yes	84.00	40.80
Crackles on auscultation	No	37.00	18.00
	Yes	169.00	82.00
Fever	No	2.00	1.00
	Yes	204.00	99.00

Continued

CXR consolidation	No	2.00	1.00
	Yes	204.00	99.00
WBC at admission	No	98.00	47.60
	Yes	108.00	52.40
Bacterial infection	No	97.00	47.10
	Yes	109.00	52.90

3.1.3. Outcomes of under 5 Years Admitted for Pneumonia

Table 3 illustrates outcomes of under-5-year-olds admitted for pneumonia in terms of frequencies and percentages according to their categories.

Table 3. Outcomes of under 5 years admitted for pneumonia.

Variable		Number	Percent
Hospital stays	Short	50.00	24.30
	Long	156.00	75.70
Outcomes	Died	27.00	13.10
	Recovered	179.00	86.90

3.1.4. Cross-Tabulation of Risk Factors and Outcomes of under 5 Years Admitted for Pneumonia

Table 4 illustrates the cross-tabulation of the independent variable and dependent variable in terms of P values and chi².

Table 4. Cross-tabulation of risk factors and outcome of under 5 years admitted for pneumonia.

Variable		Outcome		Chi ²	P value
		Died	Recovered		
Age	0 - 1	16.00	92.00	4.61	0.06
	>1 - 5 years	11.00	87.00		
Sex	Female	13.00	54.00	3.45	0.08
	Male	14.00	125.00		
Decreased level of consciousness	No	2.00	147.00	65.44	0.001*
	Yes	25.00	32.00		
Hypoxemia	No	2.00	141.00	56.28	0.001*
	Yes	25.00	38.00		
Severe pneumonia	No	1.00	85.00	18.49	0.001*
	Yes	26.00	94.00		
Cyanosis	No	3.00	118.00	29.08	0.001*
	Yes	24.00	61.00		
Wheezing	No	25.00	128.00	5.30	0.02*
	Yes	2.00	50.00		
Tachycardia	No	1.00	44.00	5.99	0.01*
	Yes	16.00	135.00		

Continued

Tachypnea	No	2.00	30.00	1.56	0.16
	Yes	25.00	149.00		
Convulsions	No	12.00	151.00	22.63	0.001*
	Yes	15.00	28.00		
Chest indrawing	No	4.00	71.00	6.26	0.02*
	Yes	23.00	108.00		
Anemia	No	1.00	121.00	39.66	0.001*
	Yes	26.00	58.00		
Crackles on Chest auscultation	No	1.00	36.00	4.29	0.06
	Yes	26.00	143.00		
Fever	No	1.00	1.00	2.41	0.25
	Yes	26.00	178.00		
Bacterial pneumonia	No	3.00	94.00	16.14	0.001*
	Yes	24.00	85.00		
Lungs consolidation	No	0.00	2.00	0.31	0.70
	Yes	27.00	177.00		
Increased WBC	No	3.00	95.00	16.56	0.001*
	Yes	24.00	84.00		
Hospital stay	Short	27.00	23.00	96.90	0.001*
	Long	0.00	156.00		

*Statistically significant ($P < 0.05$).

3.1.5. Multivariate Analysis of Factors Associated with Pneumonia Outcomes

Table 5 illustrates multivariate analysis of risk factors associated with mortality among children under five years with pneumonia.

Table 5. Multivariate analysis of factors associated with pneumonia outcomes.

Variables		Adjusted Odd Ratio	P value	95% Confidence Interval	
				LB	UP
Hypoxemia	No	1.00	0.001*	0.12	19.50
	Yes	15.22			
Severe pneumonia	No	1.00	0.03*	0.12	18.80
	Yes	1.51			
Cyanosis	No	1.00	0.001*	1.00	10.30
	Yes	8.11			
Wheezing	No	1.00	0.001*	0.13	5.05
	Yes	2.61			
Chest indrawing	No	1.00	0.01*	0.89	2.53
	Yes	1.50			

Continued

Bacteria	No	1.00	0.001*	0.32	5.16
	Yes	3.02			
CXR Consolidation	No	1.00	0.001*	2.15	9.81
	Yes	4.62			
Hyperleukocytosis	No	1.00	0.001*	5.37	19.56
	Yes	10.80			

*Statistically significant ($P < 0.05$).

3.2. Analysis and Interpretation of Data

3.2.1. Socio-Demographic Characteristics of Participants

The socio-demographic characteristics of the under-five children admitted for pneumonia were presented in **Table 1**; more than half of the participants belonged to the 0 - 1 years group, while 48.05% were aged one to five years. Of the under-five children admitted for pneumonia, 67.5% were female, while 32.5% were male; 41.7% were born to mothers with no formal education, 27.2% to mothers who completed at least primary school, and 14.6% and 16.5% to mothers who completed secondary and university, respectively. Regarding immunization, almost all under-five children have completed immunization.

3.2.2. Medical Data and Outcome of under 5 Years Admitted for Pneumonia

The descriptive analysis of medical data and outcomes for children under 5 years admitted with pneumonia is presented in **Table 3**, which shows that 13.10% died and 86.90% recovered. It also shows that 75.70% stayed at the Hospital for a long time and 24.30% for a short time. Regarding signs and symptoms of pneumonia, 41.1%, 41.3%, 84.5%, 36.4%, 82%, and 99% experienced wheezing, cyanosis, tachypnea, chest indrawing, crackles on auscultation, and fever, respectively, while 58.8% had severe pneumonia.

3.2.3. The Outcomes of under-5-Year-Olds Admitted for Pneumonia

Regarding hospital stay, 24.3% had a short hospital stay, while 75.7% had a long hospitalization (more than ten days). Regarding the prognosis of pneumonia, 13.1% of the under-five children died from pneumonia, while 86.9% survived pneumonia.

3.2.4. Cross-Tabulation of Factors Associated with Outcome among Under-Five Admitted for Pneumonia

The cross-tabulation of factors associated with outcome among under-fives admitted for pneumonia is presented in **Table 2**. Significant associations between factors and pneumonia outcomes were found with decreased level of consciousness, hypoxemia, severe pneumonia, cyanosis, wheezing, tachycardia, convulsions, chest indrawing, anemia, crackles on chest auscultation, bacterial pneumonia, and hyperleukocytosis ($P < 0.05$).

3.2.5. Multivariate Analysis of Factors Associated with Pneumonia Outcomes

Table 5 presents the binary logistic regression of factors associated with pneumonia outcomes. Based on the results, participants who experienced hypoxemia had a 15.2-fold higher chance of a poor outcome than those without hypoxemia (AOR = 15.20, $P < 0.001$, 95% CI [0.12 - 19.50]).

The under five children who experienced cyanosis, wheezing, chest indrawing, CXR consolidation, hyperleukocytosis, have had 8.108, 2.6, 1.5, 4.6, and 10.8 respective times chance to poor prognosis, with respectively (AOR = 8.11, $P < 0.001$, 95% CI [1.00 - 10.30]), (AOR = 2.60, $P < 0.001$, 95% CI [0.13 - 5.049]), (AOR = 1.50, $P = 0.007$, 95% CI [0.89 - 2.53]), (AOR = 4.60, $P < 0.001$, 95% CI [2.15 - 9.81]) and (AOR = 10.80, $P < 0.001$, 95% CI [5.37 - 19.56]), respectively.

3.3. Discussion of Findings

The present study was intended to determine the mortality rate of the under-five-year-old children admitted for pneumonia and the associated risk factors. The findings have shown that 67.5% of participants were female. Of the under-five children admitted in pediatric service for pneumonia, symptoms of pneumonia, 41.1%, 41.3%, 84.5, 36.4%, 82% and 99% experienced wheezing, cyanosis, tachypnea, chest indrawing, crackles on auscultation, and fever as the signs and symptoms associated with pneumonia, while 58.5% of the under-five children admitted for pneumonia experienced severe pneumonia.

WHO reported a similar finding, with studies in various regions suggesting that approximately 20% - 30% of children hospitalized for pneumonia may have severe cases; this small difference may be attributed to the WHO report averaging high- and low-income countries [13].

3.3.1. Mortality Rate among the Under-Five Children Admitted for Pneumonia

The present study found a hospital case-fatality rate of 13.1% (27/206) among children under five admitted with pneumonia. The description of this rate as “low mortality” should be interpreted cautiously. Rwanda’s national under-five mortality rate was 27.9 deaths per 1000 live births in 2024, while the corresponding rate for sub-Saharan Africa was 71.6 per 1000 live births. These are population-level, all-cause mortality measures and therefore are not directly comparable with the pneumonia-specific inpatient case-fatality rate reported in this study [14].

In contrast, recent African hospital-based studies provide more appropriate clinical benchmarks: Adbela *et al.* (2024) reported a 6.4% case-fatality rate among pediatric pneumonia admissions in Eastern Ethiopia, while Kassaw *et al.* (2023) reported 4.7% mortality among under-five children with severe community-acquired pneumonia in Ethiopia. The 13.1% rate observed at CHUB is therefore within the broad historical African hospital range of approximately 3% - 20% reported by Bamford *et al.* (2018), but it is higher than several recent Ethiopian hospital estimates. This suggests that the finding represents a substantial inpatient

mortality burden rather than a clearly low mortality rate, and it warrants interpretation in relation to case severity, referral patterns, comorbidities, and access to timely oxygen and appropriate treatment [15]-[17].

In East Africa, a study conducted in Uganda, the mortality rate among under-five children admitted for pneumonia varied from 5% to 15% with the average of 11% [18].

A multicenter study from Nigeria also shows that pneumonia outcomes can improve with stronger prevention. Pneumonia hospitalizations and mortality among children aged 3 - 24 months across three Nigerian hospitals from 2013 to 2020 were examined. In this study, the case-fatality rates declined after introducing the 10-valent pneumococcal conjugate vaccine at all three sites, although the magnitude and statistical significance of the reduction varied by site [19].

These findings underscore the importance of vaccination and effective pneumonia prevention, alongside timely hospital management, in reducing childhood pneumonia mortality in African settings.

Another study from Ethiopia aligns with these findings. 580 children under age five with severe community-acquired pneumonia were followed. Among them, 27 deaths (4.7%) were reported during hospitalization. Mortality was associated with heart disease, prior admission for severe community-acquired pneumonia, severe wasting (weight-for-length < -3 Z score), impaired consciousness at admission, and pleural effusion [16]. The association with impaired consciousness is particularly relevant to the present study, in which reduced consciousness was also linked to poor outcome, suggesting that markers of advanced clinical severity at admission are important predictors of mortality across African hospital settings.

3.3.2. The Factors Associated with Mortality of Pneumonia among Under-Five Children Admitted for Pneumonia

The present study found that patients who presented with decreased level of consciousness, hypoxemia, severe pneumonia, cyanosis, wheezing, tachycardia, convulsions, chest indrawing, anemia, crackles on chest auscultation, bacterial pneumonia, and hyperleukocytosis at admission were prone to poor prognosis (mortality) ($P < 0.05$).

Multivariate analysis showed that the under five-children who experienced, cyanosis, CXR consolidation, hyperleukocytosis on admission are the risk factors of mortality with the following AOR 95% CI and Values: (AOR = 8.11, 95% CI [1.00 - 10.30]) $P < 0.001$, (AOR = 4.60, 95% CI [2.15 - 9.81] $P < 0.001$, and (AOR = 10.80, 95% CI [5.37 - 19.56] $P < 0.001$), respectively.

The same results were reported in a study conducted in South Africa, where the presence of severe pneumonia at admission, presence of comorbidities (HIV, malnutrition), the delayed time of starting the appropriate antibiotics, and inaccessibility to oxygen therapy increased the likelihood of increased mortality among the under-five children admitted for pneumonia [17].

In a study conducted in Ethiopia, the reported risk factors for increased mortality among the under-five children admitted for pneumonia were malnutrition, late

presentation to healthcare facilities, presence of complications like respiratory failure, comorbidities (particularly HIV), and young age (especially under 12 months). The odds of pneumonia were higher among children younger than one year than among older children [20].

Similarly, a 6.4% mortality rate was reported among 204 pediatric patients admitted to Hiwot Fana Comprehensive Specialized University Hospital in Eastern Ethiopia with pneumonia. Malnutrition, lack of vaccination, altered mental status at admission, and complicated pneumonia were independently associated with mortality. The finding that altered mental status and complicated disease were linked to poor outcomes complements the present observation that decreased consciousness, hypoxemia, cyanosis, and radiographic consolidation identify children at higher risk of death [15].

Moreover, in East Africa, a study conducted in Uganda suggested that risk factors for increased mortality among under-fives admitted for pneumonia include severe malnutrition, co-infection with HIV, age under twelve months, limited access to oxygen therapy, and complications such as sepsis and respiratory failure [18].

Together, these studies underscore the importance of early recognition of severe clinical features and prompt management of children presenting with advanced pneumonia.

4. Conclusion and Recommendation

4.1. Conclusions

The present study has found that 51.9%, 67.5% of participants, were aged of less than one year and female, respectively, of the under five children suffered from pneumonia, 75.7% were hospitalized for more than ten days, while the mortality rate among the under-five admitted for pneumonia, 13.1% died, and 86.9% recovered from pneumonia.

Furthermore, this study found that decreased level of consciousness, hypoxemia, severity of pneumonia, cyanosis, wheezing, tachycardia, convulsions, chest indrawing, anemia, crackles on chest auscultation, bacterial pneumonia, and hyperleukocytosis were associated with increased mortality ($P < 0.05$).

Hypoxemia increased the risk of death 15.2 times; cyanosis, wheezing, chest indrawing, CXR consolidation, and hyperleukocytosis increased the risk of death by 8.108, 2.6, 1.5, 4.6, and 10.8 times, respectively.

4.2. Limitations

This study has several limitations. First, the retrospective design relied on information documented in medical records, limiting control over the completeness and accuracy of the available data. Second, the study was conducted at a single tertiary hospital, which may limit the generalizability of the findings to other hospitals or community settings in Rwanda. Third, differences in documentation and diagnostic recording may have resulted in misclassification of some clinical vari-

ables. Finally, some potentially important confounders may not have been measured or available in the records, so residual confounding cannot be excluded.

4.3. Recommendations

According to the findings of the present study on the mortality rate of under-five children admitted for pneumonia and the risk factors at CHUB are presented as follows:

To the parents: To consult health facilities as early as possible because the risk factors of mortality identified on admission were characteristic of advanced progression of disease which may be due to the delay in consultation.

To the researchers: To conduct further research to find the necessary measures to further reduce the mortality rate among under-fives suffering from pneumonia.

Author Contributions

Muhayimana Daniel: Conceptualization, methodology, data collection, data analysis, and manuscript drafting. Rebecca Kavira Kasine & Umutesi Josiane: Literature review, interpretation of findings, manuscript writing, and critical revision. Niyigena Rose & Niragire Leonie: Contribution to data collection, manuscript review, and approval of the final version. Nyirabazungu Eugenie & Uwineza Didi Victoire: Clinical interpretation, manuscript review, and approval of the final version.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix: Data Collection Form

Demographic factors	Response
Age<	0 - 1 years
	2 - 3 years
	4 - 5 year
Inadequate immunization	Yes
	No=
Smoking at home	Yes
	No
parental education	No formal education
	Primary
	Secondary
	University
Suboptimal breastfeeding	Yes
	No
sex	Female
	Male
Crowding at home	Yes
	No
Clinical signs and comorbidities	
Decreased conscious state	Yes
	No
Hypoxaemia†	Yes
	No
severe pneumonia	Yes
	No
Cyanosis	Yes
	No
Pallor	Yes
	No
Malnutrition	Yes
	No
Wheeze	Yes
	No
Congenital heart disease	Yes
	No
Tachycardia§	Yes
	No
	No
Tachypnoea	Yes
	No

Continued

Convulsions	Yes
	No
Heart failure	Yes
	No
Diarrhoea	Yes
	No
Chest indrawing	Yes
	No
Anemia	Yes
	No
Crackles on auscultation	Yes
	No
Asthma	Yes
	No
Non-asthma lung condition	Yes
	No
Neurodevelopmental condition	Yes
	No
Fever ($\geq 38^{\circ}$ Celsius)	Yes
	No
low birth weight	Macrosomia
	Normal
	Low birthweight
	Very low birthweight
	Extremely low birth
preterm	Yes
	No
Clinical investigations and aetiology	Response
Bacterial (undifferentiated)	No
	Yes
CXR consolidation	No
	Yes
Leukopenia (low WCC)	Low
Leucocytosis (high WCC)	High
Survived	Normal
	Yes
	No