Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Prevalence of pneumonia and associated risk factors among neonates in selected health facilities in Wakiso district, Uganda

Bridget Namwanga

bridgetnamwanga@gmail.com

Makerere University

Mathius Amperiize

Makerere University

David Musoke

Makerere University

Edith Nakku Joloba

Makerere University

Angela Kisakye

Makerere University

Research Article

Keywords: pneumonia, neonates, associated factors, prevalence

Posted Date: September 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10522692/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Pneumonia remains a significant challenge in Uganda, especially among neonates in health facilities, which barely have Neonatal Intensive Care Units (NICUs) in place. Whereas the Ministry of Health (MOH) has implemented the Integrated Community Case Management on three killer diseases, including pneumonia in all districts, it remains prevalent among neonates across the country. Therefore, this study aimed to assess the prevalence and associated factors of pneumonia among neonates in selected health facilities in Wakiso district, Uganda.

Methods

A cross-sectional study utilizing quantitative data collection methods was conducted among 342 mothers/caregivers. A structured questionnaire uploaded on the Kobo Collect application software was administered through face-to-face interviews to capture data on socio-demographic characteristics, environmental factors, and associated factors. A data abstraction form was used to collect data on neonatal factors from the maternal and neonatal health registers. Data was downloaded into Microsoft Excel and later imported into STATA version 17.0 for analysis. Descriptive statistics were performed to summarize continuous and categorical data. A modified Poisson regression model was used to establish the factors associated with pneumonia.

Results

The study revealed that 12.6% (43/342) of the neonates were diagnosed with pneumonia as recorded in the maternal and neonatal health registers. Marital status (APR = 0.90, 95% CI: 0.85–0.96) and common source of energy for cooking (APR = 0.89, 95% CI: 0.81–0.97), (APR = 0.93, 95% CI: 0.88–0.99) were factors associated with neonatal pneumonia. However, attendance of antenatal care (APR = 1.13, 95% CI: 1.03–1.23), prematurity (APR = 1.23, 95% CI: 1.05–1.44), birthweight (APR = 1.08, 95% CI: 1.01–1.16), knowledge level (APR = 1.10, 95% CI: 1.03–1.18) and common cooking place (APR = 1.08, 95% CI: 1.04–1.13) were positively associated with pneumonia among neonates.

Conclusion

There's a need to implement interventions targeted at improving neonatal health outcomes. These interventions should target caregivers who are married or cohabiting, do not attend antenatal care, have limited knowledge of pneumonia, those whose common energy source for cooking is charcoal, and those whose common cooking place is a kitchen attached to the living room.

Introduction

Pneumonia is one of the leading infectious causes of death among children under five years of age and persists as a major public health problem worldwide (1). Pneumonia accounts for more than 700,000 deaths annually among children under five years of age (2). The greatest global incidence of pneumonia among children occurred in South Asia, with a total caseload of about 2,500 admissions per 100,000 as compared to 1,620 admissions per 100,000 in Central and West Africa (2). While there has been a drastic improvement in the number of preventable deaths of children under five years in sub-Saharan Africa, slow declines have been observed in neonatal mortality (3). In South Africa, of the 1,143 live births, there were 174 children admitted with pneumonia, and of these, 27 percent were below the age of 2 months (4). In western Uganda, at a Teaching hospital in Bushenyi district, a prevalence of pneumonia (25.6%) among children who suffered from acute respiratory symptoms was reported (5).

Among neonates, pneumonia accounts for the highest deaths registered in sub-Saharan Africa (1). As compared to older children, neonates have a limited capacity to defend against pulmonary infection (3). They are rarely able to do so, attributed to their compromised immune system, which predisposes them to a heightened risk of developing pneumonia (3). Unfortunately, there is a failure to recognize respiratory distress in neonates (3). Risk factors associated with susceptibility to pneumonia among neonates include preterm birth, lack of breastfeeding, and impaired immunity, among others (6). Neonates are also at a greater risk of dying from infectious diseases such as pneumonia if born in rural areas, in poor households, and to a mother who has no basic education (7).

Nosocomial and ventilator-associated infections, such as pneumonia, have been identified as a major concern influencing morbidity and mortality in neonatal intensive care units (NICUs) (8). Pneumonia, depending on the timing and the source of infection, manifests as early-onset or late-onset. Early-onset pneumonia first manifests as a part of generalized sepsis at or within hours of birth, whereas late-onset pneumonia usually occurs within 7 days of life, most commonly among neonates in the NICUs, which is also known as ventilator-associated pneumonia (9). Pneumonia contributes enormously to the burden of ill health, morbidity, and mortality among neonates and can cause long-term complications such as chronic lung disease, impaired growth, and neurodevelopmental impairment (10).

Uganda joined the rest of the world in 2013 in implementing the Global Action Plan for Prevention and Control of Pneumonia and Diarrhea (GAPPD). This plan emphasized the introduction of the pneumococcal conjugate vaccine into the routine immunization schedule, which was complemented by other low-cost interventions such as exclusive breastfeeding (11). Despite efforts made to improve the quality of neonatal healthcare, addressing pneumonia's impact on neonates remains a complex issue, yet the burden continues to rise within resource-constrained settings (3). In some low-and middle-income (LMIC) settings, this burden is exacerbated by the unavailability of oxygen and antibiotics, which makes management quite challenging (3).

Although pneumonia is preventable, neonates remain at risk of contracting the disease, given that the pneumococcal conjugate vaccine is given at six weeks of life. Moreover, current research around pneumonia has largely focused on infants 2 to 59 months old, implying that data for children below 1 month old is limited. Yet there is evidence showing an upward trend in the incidence of pneumonia among

neonates. Therefore, this study sought to assess the prevalence of pneumonia among neonates and the associated factors, generating data that is essential in designing targeted interventions and improving neonatal health outcomes in health facilities. in Wakiso district.

Methodology

Study setting and design

A facility-based descriptive cross-sectional study utilizing quantitative data collection methods was conducted from March to December 2024.

This study was conducted in Wakiso, a district in the Central Region of Uganda that partly encircles Kampala, the capital city. Wakiso town, where the headquarters are located, lies approximately 20 kilometers by road, northwest of Kampala. Wakiso district has twelve divisions, six sub-counties, and nine town councils (12).

Wakiso District is Uganda's second most populated district, with an official population of 3,411,177. The district's economy relies on a blend of agriculture, commercial enterprise, and manufacturing, with the majority of the working population primarily engaged in both subsistence and cash-crop farming alongside localized fishing and services (13)

The district health structure consists of seven subdistricts (where each subdistrict consists of only one health centre IV), and each is managed by the district health officer at the health centre (HC) IV aided by the senior nursing officer in charge of all the HC IIIs and HC IIs. The study population was sampled from six out of the eight health centre IVs: Wakiso HC IV, Namayumba HC IV, Kajjansi HC IV, Ndejje HC IV, Buwambo HC IV and Kasangati HC IV.

Study population

The study population was all children less than 28 days old who sought care at the pediatric units, maternity wards, or outpatient departments (OPD) of the selected health centre IVs from February to June 2024. We defined neonates as infants up to 28 days of age who sought care at the pediatric units and maternity wards during this period. We excluded neonates who were too ill or unconscious and had been referred to a referral hospital.

Sampling

We estimated a study sample size of 342 participants using the formula for cross-sectional studies developed by Kish Leslie (14) with a power of 80%; at 95%, Confidence Interval, Z value of 1.96, 0.05 margin of error, 10.9% prevalence of pneumonia among neonates from a study that was done at the pediatric emergency unit of Mulago national referral hospital (15), and a non-response rate of 10%. Sampling was done in two stages. Wakiso has seven health sub-districts with one health centre IV in each. The first stage

was to make a random selection of four health centre IVs out of the seven in Wakiso district. This was done through line listing of all seven health centre IVs. Then, computer-generated random numbers were used, where the health centres were selected for sampling without replacement, and this was done according to urban (3 out of 4 health centre IVs) and rural (1 out of 2 health centre IVs) catchment areas. Only four health centres were selected because they are representative of all seven. To determine the number of participants to be selected at each health facility, a probability proportionate sampling approach based on the average monthly proportion of the total newborn mothers received at each health facility was applied. This was to ensure that health centres with a larger number of pneumonia positives are more represented in the sample. The second stage: after the sample size for each health centre IV was obtained, neonates were consecutively selected after seeking care at the health centre. For each selected neonate, only a mother or primary caregiver was interviewed.

Data collection

Structured interviews and data abstraction from the neonatal intensive care unit registers and maternity newborn registers were conducted in the selected health centre IVs. A structured questionnaire was uploaded into the Kobo Collect mobile application. This was then administered to mothers or caregivers of the neonates through face-to-face interviews by trained medical school doctors in their final year. The structured questionnaire was translated into *Luganda*, the commonly spoken language in Wakiso district. The questionnaire obtained data on socio-demographic characteristics, knowledge of pneumonia, intra-partum factors, and environmental factors of the caregivers. A data abstraction form was designed to collect data on neonatal intra-partum factors, birth outcomes, and pneumonia diagnosis during the first 28 days of life. This exercise utilized medical records of neonates admitted to the neonatal intensive care unit (NICU) and recorded in the register at selected health centre IVs, the maternal and neonatal health registers.

Study variables and measurement

Dependent variable

This study aimed to measure the prevalence of pneumonia among neonates. Prevalence was measured based on review of neonatal and maternal records at the health facility for the diagnosis of pneumonia among neonates who had symptoms such as cough, respiratory distress, nasal congestion, severe chest in drawing, grunting respiration, inability to breastfeed, convulsions, drowsiness, wheezing, presence of fever, and cyanosis. Prevalence of pneumonia was calculated by determining the proportion of neonates among the study participants who were diagnosed in the first 28 days of life with pneumonia at the selected health centre IVs from February 2024 to June 2024. This was modelled as a categorical variable.

Independent variables

Socio-demographic characteristics such as age, education level, marital status, religion, child sex, socio-economic status, number of people in the household, individual knowledge of disease, residence, and attendance of antenatal care were obtained.

Neonatal factors, such as place of delivery, type of delivery, birthweight, primary diagnosis, prematurity, prolonged labor, and delivery personnel, were obtained. Environmental factors, such as cooking fuel, a common cooking place, the place of the child while cooking, and a kitchen with a window, were obtained

Data management and analysis

The data was entered using the Kobo Collect mobile application software and was then downloaded into Microsoft Excel and cleaned through validation for accuracy, consistency, and completeness. It was analyzed using STATA version 17.0. Descriptive statistics such as mean and standard deviation were used for continuous variables such as household size, age of the caregiver, and time spent in labour, whereas frequencies and proportions were utilized to present categorical data. The prevalence of pneumonia was calculated by determining the proportion of neonates who were diagnosed with pneumonia among the selected health centre IVs. Modified Poisson was used to establish the factors associated with pneumonia among neonates. Variables with a p-value of < 0.2 at bivariate analysis were selected for inclusion in the model. Multicollinearity was checked. and in case one variable out of the selected showed a correlation coefficient ≥ 0.4 with another variable, one of the two strongly correlated variables was excluded at the multivariable analysis stage. Fischer's exact test was also done for the type of birth attendant and time spent in labour to establish whether there was a discrepancy in categories in association with neonatal pneumonia. Thereafter, model building was done by using backward elimination. A p-value < 0.05 was considered statistically significant.

Quality Control and Quality Assurance

Trained medical students in their final year were recruited to collect the data, and were trained for two days on the study protocol and ethical considerations to ensure that they adhered to and collected quality data. The data collection tools were pretested at Kisenyi Health Centre IV in Kampala, the metropolitan area, Uganda. Thorough supervision of the data collection process was done to ensure data quality. The collection tool was designed with restrictions and skips to minimize errors, and daily data reviews were carried out to detect and correct any missing or inconsistent values. The data was reviewed every day to ensure that there were no gaps or inconsistencies.

Results

Socio-demographic characteristics of the caregivers/mothers

A total of 342 neonates' mothers/caregivers were involved in this study, with a response rate of 100%. More than half, 59.4% (203/342) of the participants resided in the urban part of Wakiso district, and about a half,

53.8% (184/342) had completed secondary education. The average age of the participants was 26.6 ± 13.3 years. Nearly two-thirds, 66.7% (228/342), belonged to the 20–29 age category. Over two-thirds, 93.3% (319/342), were married or cohabiting. About a third, 32.7% (112/342), were Catholics. The average household size was 4.4 ± 1.7 members. The majority of the caregivers, 98.5% (337/342), had attended antenatal care, and of these, more than half, 52.3% (179/342), belonged to the 3–5 antenatal care visit categories (Table 1).

Table 1
Socio-demographic characteristics of the caregivers/mothers

Variable	Attribute	Frequency (N = 342)	Percentage (%)
Residence	Rural	139	40.6
	Urban	203	59.4
Education level	No formal education	10	2.9
	Primary	80	23.4
	Secondary	184	53.8
	Tertiary	68	19.9
Marital status	Married/cohabiting	319	93.3
	Separated/divorced	8	2.3
	Single/never married	15	4.4
Religion	Catholic	112	32.8
	Muslim	53	15.5
	Pentecostal	40	11.7
	Protestant	74	21.6
	Other	63	18.4
Household size (mean = 4.4, S.D ± 1.7)	0–5	125	36.5
	6–10	212	62
	10–15	5	1.5
Age of caregiver in years (mean = 26.6, S.D ± 13.3)	10–19	29	8.5
	20–29	228	66.7
	30–39	79	23.1
	40–49	6	1.8
Attendance of antenatal care	No	5	1.5
	Yes	337	98.5
Antenatal care visits attended	0–2	20	5.9
	3–5	179	52.3
	6–8	143	41.8
Asset ranking index (Socio-economic status)	Low	115	33.5

	Medium	118	35
	High	106	31.5
Knowledge of pneumonia	Low	175	51.6
	High	164	48.4

Intra-partum characteristics of the neonates

Over half, 57.3% (196/342) of the neonates were female. Nearly two-thirds, 74.9% (256/342) of the neonates had a midwife as an attendant at birth. The majority, 78.9% (270/342), were delivered at health centre IVs, and 77.2% (264/342) had a normal birth. Approximately 6.1% (21/342) were born prematurely. The average time spent in labour by the newborn mother was 9.1 ± 12.1 hours **(**Table 2**).**

Table 2
Intrapartum characteristics of neonates

Variable	Attribute	Frequency (N = 342)	Percent (%)
Sex	Female	196	57.3
	Male	146	42.7
Type of birth attendant	Family physician	25	7.3
	Midwife	256	74.8
	Obstetrician/Gynecologist	56	16.4
	Traditional birth attendants	5	1.5
Place of delivery	Clinic	9	2.6
	HCIV	270	79.0
	Home	13	3.8
	Hospital	50	14.6
Type of delivery	Caesarean	78	22.8
	Vaginal	264	77.2
Prematurity	No	320	93.6
	Yes	21	6.1
Weeks of prematurity	30	1	0.3
	32	2	0.6
	34	7	2.0
	35	7	2.0
	36	3	0.9
	40	1	0.3
Time spent in labour (hours) (mean = 8.9, S.D ± 10.7)	0–18	293	85.7
	19–36	35	10.2
	37–54	14	4.1

Environmental related factors

Overall, the majority of study participants, 86.3% (295/342), used charcoal as the most common cooking fuel. More than half, 86.5% (296/342), commonly used a separate kitchen for cooking, and 83.3% (285/342)

of the cooking places had a window. The majority of study participants, 90.6% (310/342), placed the child outside the cooking room while cooking (Table 3).

Table 3
Environmental factors related to pneumonia among neonates.

Variable	Attribute	Frequency (N = 342)	Percentage (%)
Common cooking fuel	Charcoal	295	86.3
	Electricity	5	1.5
	Gas	15	4.4
	Kerosene	1	0.3
	Wood	26	7.6
Common cooking place	In the kitchen attached to the living room	37	10.8
	In the living room	9	2.6
	In the separate kitchen	296	86.5
Kitchen with a window	No	56	16.4
	Yes	285	83.3
Place of child while cooking	Near or carried on the back	32	9.4
	Outside the cooking room	310	90.6

Prevalence of pneumonia among neonates

This study showed that the overall prevalence of pneumonia among neonates during the study period was 12.6% (43/342). More than half of pneumonia was reported among females, 60.5% (26/43), and 74.4% (32/43) resided in the urban part of Wakiso. Pneumonia was recorded among participants who were married or cohabiting 100% (43/342), and nearly a half of these completed secondary level education, 46.5% (20/43). Almost half of the neonates' caregivers who were diagnosed with pneumonia were Catholics, 44.2% (19/43) (Table 4).

Factors associated with pneumonia among neonates in selected health centre IVs in Wakiso

Neonates from households of study participants that were separated or divorced from their spouses had a 10% lower likelihood of being diagnosed with pneumonia (APR = 0.90, 95% CI: 0.85–0.96) compared to those from married or cohabiting families. Neonates of study participants who attended antenatal care had a 13% higher likelihood of being diagnosed with pneumonia (APR = 1.13, 95% CI: 1.03–1.23) when compared to those who did not. Neonates that were born prematurely had a 23% higher likelihood of being diagnosed with pneumonia (APR = 1.23, 95% CI: 1.05–1.44) as compared to those that were not born

prematurely. Neonates who weighed between (2.6–3.5) kgs at birth had an 8% higher likelihood of being diagnosed with pneumonia (APR = 1.08, 95% CI: 1.01–1.16) as compared to those whose weight at birth was not measured. Neonates of study participants with a high knowledge level had a 10% higher likelihood of being diagnosed with pneumonia (APR = 1.10, 95% CI: 1.03–1.18) when compared with those of low level of knowledge. Neonates of participants whose common source of energy used for cooking was electricity (APR = 0.89, 95% CI: 0.81–0.97) and gas (APR = 0.93, 95% CI: 0.88–0.99) were less likely to be diagnosed with pneumonia compared to those of participants who used charcoal. Neonates from households whose common cooking place was a separate kitchen had an 8% higher likelihood of being diagnosed with pneumonia (APR = 1.08, 95% CI: 1.04–1.13) as compared to those from households whose common cooking place was a kitchen attached to the living room. Neonates whose final diagnosis at birth was pneumonia had a 69% higher likelihood of having pneumonia in the first 28 days of life (APR = 1.69, 95% CI: 1.58–1.82) as compared to those whose final diagnosis at birth was normal **(**Table 4**).**

Table 4
Factors associated with pneumonia among neonates

Independent Variable	Attribute	Pneumonia diagnosis in the first 28 days of life		CPR at 95% CI	P. value	APR at 95% CI	P. value
		No	Yes				
Sex of the neonate	Female	170 (86.7)	26 (13.3)	1			
	Male	129 (88.4)	17 (11.6)	1.00 (0.94–1.06)	0.956		
Education Level	No formal education	8 (80.0)	2 (20.0)	1			
	Primary	73 (91.3)	7 (8.7)	0.89 (0.72–1.11)	0.313		
	Secondary	164 (89.1)	20 (10.9)	0.90 (0.73–1.11)	0.334		
	Tertiary	54 (79.4)	14 (20.6)	1.00 (0.81–1.25)	0.966		
Religion	Catholic	93 (83.0)	19 (17.0)	1		1	
	Muslim	48 (90.6)	5 (9.4)	0.93 (0.86–1.02)	**0.126***	0.96 (0.88–1.05)	0.405
	Other	56 (90.3)	6 (9.7)	0.94 (0.86–1.02)	0.143	0.94 (0.87–1.02)	0.176
	Pentecostal	36 (90.0)	4 (10.0)	0.93 (0.85–1.03)	0.157	1.01 (0.91–1.14)	0.75
	Protestant	65 (87.8)	8 (10.8)	0.96 (0.88–1.05)	0.399	0.97 (0.90–1.05)	0.412
Marital status	Married/cohabiting	276 (86.5)	43 (13.5)	1		1	
	Separated/divorced	8 (100.0)	0 (0.0)	0.90 (0.87–0.92)	**< 0.001***	0.90 (0.85–0.96)	**0.002***

	Single/never married	15 (100.0)	0 (0.0)	0.90 (0.87–0.92)	**< 0.001***	0.94 (0.90–1.00)	0.051
Attendance of antenatal care	No	5 (100.0)	0 (0.0)	1		1	
	Yes	294 (87.2)	43 (12.8)	1.11 (1.08–1.14)	**< 0.001***	1.13 (1.03–1.23)	**0.01***
Type of birth attendant	Family physician	24 (96.0)	1 (4.0)	1		1	
	Midwife	221 (86.3)	35 (13.7)	1.12 (1.08–1.16)	**< 0.001***	1.07 (1.00–1.13)	0.058
	Obstetrician/Gynecologist	49 (87.5)	7 (12.5)	1.11 (1.03–1.19)	0.006	1.05 (0.96–1.13)	0.322
	Traditional birth attendants	5 (100.0)	0 (0.0)	1		1	
Type of delivery	Caesarean	67 (85.9)	11 (14.1)	1			
	Vaginal	232 (87.8)	32 (12.2)	0.99 (0.92–1.07)	0.827		
Prematurity of the neonate	No	284 (88.8)	36 (11.2)	1		1	
	Yes	14 (66.7)	7 (33.3)	1.22 (1.04–1.42)	**0.012***	1.23 (1.05–1.44)	**0.008***
Household size	0–5	113 (90.4)	12 (9.6)	1		1	
	6–10	181 (85.4)	31 (14.6)	1.06 (0.99–1.12)	0.071	0.10 (0.94–1.06)	0.953
	10–15	5 (100.0)	0 (0.0)	0.93 (0.89–0.97)	**< 0.001***	0.87 (0.74–1.05)	0.159
Antenatal care visits attended	0–2	19 (95.0)	1 (5.0)	1			
	3–5	161 (89.9)	18 (10.1)	1.08 (1.04–1.13)	**< 0.001***		
	6–8	119 (83.2)	24 (16.8)	1.15 (1.10–1.21)	**< 0.001***		

Time spent in labour	0–18	255 (87.0)	38 (13.0)	1			
	19–36	33 (94.3)	2 (5.7)	0.94 (0.88–1.03)	0.206		
	37–54	11 (78.6)	3 (21.4)	1.03 (0.87–1.20)	0.752		
Birthweight of the neonate	Not weighed	6 (100.0)	0 (0.0)	1		1	
	1.5–2.5	26 (89.7)	3 (10.3)	1.10 (0.99–1.22)	0.055	1.04 (0.94–1.15)	0.468
	2.6–3.5	190 (86.3)	30 (13.7)	1.11 (1.07–1.16)	**< 0.001***	1.08 (1.01–1.16)	**0.031***
	3.6–4.8	77 (88.5)	10 (11.5)	1.10 (1.04–1.17)	**< 0.001***	1.08 (0.99–1.17)	0.077
Residence	Rural	128 (92.0)	11 (8.0)	1		1	
	Urban	171 (84.2)	32 (15.8)	1.07 (1.01–1.13)	**0.021***	1.00 (0.94–1.06)	0.916
Age of caregiver	10–19	29 (100.0)	0 (0.0)	1			
	20–29	200 (87.7)	28 (12.3)	1.11 (1.07–1.15)	**< 0.001***		
	30–39	64 (81.0)	15 (19.0)	1.16 (1.08–1.25)	**< 0.001***		
	40–49	6 (100.0)	0 (0.0)	1			
Place of delivery	Clinic	9 (100.0)	0 (0.0)	1			
	HCIV	229 (84.8)	41 (15.2)	1.13 (1.09–1.18)	**< 0.001***		
	Home	13 (100.)	0 (0.0)	1			
	Hospital	48 (96.0)	2 (4.0)	1.02 (0.98–1.06)	0.308		

Asset ranking index (Socio-economic status)	Low	99 (87.6)	14 (12.4)	1		1	
	Medium	104 (88.1)	14 (11.9)	0.98 (0.91–1.05)	0.594	0.99 (0.92–1.06)	0.699
	High	92 (86.7)	14 (13.3)	0.98 (0.91–1.06)	0.657	1.01 (0.94–1.09)	0.848
Knowledge of Pneumonia	Low	164 (93.7)	11 (6.3)	1		1	
	High	133 (81.0)	31 (19.0)	1.13 (1.06–1.19)	**< 0.001***	1.10 (1.03–1.18)	**0.004***
Has the child ever shown signs and symptoms of pneumonia	No	261 (96.3)	10 (3.7)	1			
	Yes	38 (54.2)	32 (45.8)	1.42 (1.31–1.54)	**< 0.001***		
What was the diagnosis							
	Flu and cough	15 (83.3)	3 (16.7)	1			
	Malaria	5 (100.0)	0 (0.0)	0.86 (0.74–0.99)	0.042		
	Meconium Aspiration Syndrome	1 (100.0)	0 (0.0)	0.86 (0.74–0.99)	0.042		
	Neonatal sepsis	5 (100.0)	0 (0.0)	0.86 (0.74–0.99)	0.042		
	None	9 (100.0)	0 (0.0)	0.86 (0.74–0.99)	0.042		
	Pneumonia	3 (9.7)	28 (90.3)	1.63 (1.39–1.91)	**0.001***		
Common cooking fuel	Charcoal	255 (86.4)	40 (13.6)	1		1	
	Electricity	4 (80.0)	1 (20.0)	0.89 (0.86–0.92)	**< 0.001***	0.89 (0.81–0.97)	**0.009***
	Gas	15 (100.0)	0 (0.0)	0.89 (0.86–	**< 0.001***	0.93 (0.88–	**0.027***

				0.92)		0.99)	
Common cooking place	Kerosene	1 (100.0)	0 (0.0)	0.89 (0.86–0.92)	**< 0.001***	1.11 (0.99–1.24)	0.074
	Wood	24 (92.3)	2 (7.7)	0.96 (0.87–1.06)	0.46	0.97 (0.88–1.07)	0.553
	In the kitchen attached to the living room.	35 (94.6)	2 (5.4)	1		1	
	In the living room.	9 (100.0)	0 (0.0)	1	**< 0.001***	0.99 (0.92–1.07)	0.853
	In the separate kitchen.	255 (86.1)	41 (13.9)	1.13 (1.09–1.16)	**< 0.001***	1.08 (1.04–1.13)	**< 0.001***
Kitchen with a window	No	51 (91.1)	5 (8.9)	1			
	Yes	247 (86.7)	38 (13.3)	1.02 (0.95–1.10)	0.585		
Place of the child while cooking	Near or carried on the back	30 (93.8)	2 (6.3)	1		1	
	Outside the cooking room	269 (86.7)	41 (13.3)	1.05 (0.96–1.14)	0.283	1.01 (0.94–1.08)	0.851
Neonate's final diagnosis at birth	Normal	287 (88.8)	36 (11.2)	1		1	
	Other	12 (80.0)	3 (20.0)	1.09 (0.92–1.30)	0.286	1.06 (0.87–1.29)	0.56
	Pneumonia	0 (0.0)	4 (100.0)	1.83 (1.78–1.88)	**0.001***	1.69 (1.58–1.82)	**< 0.001***

Statistically significant at 95% confidence interval at a p.value < 0.05.

Discussion

In this study, over 12.6% of neonates were diagnosed with pneumonia within the first 28 days of life, indicating a notable burden in Health Centre IVs in Wakiso district, Uganda, thus underscoring an important public health concern. Given the vulnerability of neonates due to their immature immune systems, this level of prevalence highlights the need for strengthened preventive and early detection strategies within routine maternal and newborn care. The findings further identify a combination of socio-demographic, clinical, and environmental factors associated with neonatal pneumonia, including caregiver characteristics, antenatal

care attendance, prematurity, birthweight, caregiver knowledge, and household air pollution. Collectively, these results emphasize the importance of integrated, context-specific public health interventions that promote maternal and caregiver awareness, improve access to quality antenatal and neonatal care, and address modifiable household risk factors such as cooking practices, in order to reduce the burden of neonatal pneumonia and improve neonatal health outcomes.

This study found that a notable number of neonates (12.6%) were diagnosed with pneumonia in the first 28 days of life. This prevalence is concerning as neonates are barely able to defend themselves against pulmonary infection attributed to their compromised immune system, which predisposes them to a heightened risk of developing pneumonia (3). These findings are relatively similar to those of a study that was done in an Egyptian intensive care unit on neonatal nosocomial infection surveillance, which revealed 11.3% pneumonia as the most frequently occurring infection (8). These findings are in contrast with a study that was done in a tertiary care hospital in western Nepal that revealed that the prevalence of ventilator-associated pneumonia in the NICU was 24% (16). The difference in these findings could be due to variations in the presence and operation of NICUs at the health centre IVs in Wakiso district, hospital infrastructure, and intra-partum maternal and neonatal factors such as place of delivery, type of delivery, type of birth attendant, prematurity, and neonate's birthweight. In addition, the study in Wakiso district was conducted in a health centre IV setting, while the western Nepal study was conducted in a tertiary care hospital setting, which was a point of referral for severe cases, hence recording a higher prevalence. These findings emphasize the importance of context-specific interventions and tailored approaches to address pneumonia infections among neonates effectively.

Findings from this study revealed that all neonates who were diagnosed with pneumonia in the first 28 days of life were from caregivers who were either married or cohabiting, and nearly half of these completed secondary level education. This could be explained by several factors, such as birthweight, socioeconomic status, knowledge of pneumonia, prematurity, and type of cooking fuel commonly used at home. These findings are relatively similar to a cross-sectional study that was done in public health facilities in Ethiopia, which reported that the highest pneumonia rate was observed among married parents, 70.7% (17). However, comparing these findings with studies from other settings is challenging because existing research has not consistently focused on neonatal pneumonia but rather pneumonia among children under five years, which makes this study's findings valuable. This highlights the need for targeted health education and context-specific interventions that address household and caregiver-related risk factors, even within seemingly stable family structures, to effectively reduce the burden of neonatal pneumonia.

The study revealed that neonates from households of study participants who were separated or divorced from their spouses had a lower likelihood of being diagnosed with pneumonia compared to those from married or cohabiting families. This could be due to the fact that married caregivers may face more socio-economic challenges, making it difficult to afford or access healthcare services in time. This result is consistent with studies that were done in northeast Ethiopia and northcentral Ethiopia, which showed that nearly three- quarters of married caregivers had children with pneumonia (18), (17). This is also similar to a cross-sectional study that was done in government hospitals in Iraq which revealed that majority of the pneumonia was seen among children whose parents were married (19). These studies highlight the

potential of leveraging financial literacy and empowered communities to drive timely and appropriate healthcare seeking behaviors.

Our study established that neonates of participants who attended antenatal care had a higher likelihood of being diagnosed with pneumonia. This finding is somewhat counterintuitive, as antenatal care (ANC) is generally expected to improve maternal knowledge, promote preventive practices, and enhance timely healthcare seeking. A possible explanation is that mothers who attend ANC are more likely to recognize symptoms and seek care promptly, resulting in higher detection and diagnosis of pneumonia. Additionally, women with high-risk pregnancies may attend antenatal care more frequently, and these underlying risk factors (such as prematurity or low birthweight) could increase the likelihood of neonatal pneumonia. This aligns with the findings of a case-control study in India that revealed that participants who had attended antenatal care had a high risk of neonatal pneumonia (20). Similarly, a nationally representative case-control study in India by Fadel et al. found that women often sought facility-based maternal and newborn care due to existing complications or adverse perinatal conditions, which contributed to higher observed neonatal mortality and morbidity among facility users (21). These findings reinforce the importance of not only promoting antenatal care attendance but also strengthening the quality and content of ANC services to ensure effective risk identification, prevention, and early management of neonatal conditions.

In our study, neonates who were born prematurely had a higher likelihood of being diagnosed with pneumonia as compared to those who were not born prematurely. This is probably due to neonates having lungs that are not fully developed and an immunocompromised immune system without the mother's antibodies to defend against infections, hence the newborns being susceptible to diseases such as pneumonia. Prematurity in its case alone increases the vulnerability of the newborn to ventilator-associated pneumonia. This is in line with findings from a systematic review and meta-analysis study in India, which showed that neonates who were premature had a higher likelihood of developing ventilator-associated pneumonia (22). Similarly, a retrospective case-control study conducted in China by Xu et al. reported that prematurity was significantly associated with neonatal pneumonia among low birth weight neonates (23). These findings highlight the importance of attending ANC aimed at enhancing awareness, therefore, improved and healthier lifestyles to prevent the avoidable premature related births.

Our study found that a higher proportion of neonates diagnosed with pneumonia were female compared to males. However, this finding should be interpreted with caution, as it may have been influenced by sampling variation, particularly given the higher number of female neonates included in the study. There is also no strong or consistent biological evidence suggesting that female neonates are inherently at higher risk of pneumonia. This finding contrasts with evidence from a South African birth cohort study, which reported that male sex was associated with an increased risk of pneumonia in early life (24). Similarly, evidence from a South African hospital-based surveillance analysis shows that male neonates are more commonly affected by severe infectious conditions, including pneumonia and bloodstream infections, reflecting higher vulnerability among male infants in neonatal populations (25). The inconsistency between our findings and those from other studies suggests that the observed sex difference in our study is likely not a true biological effect but may instead reflect population structure, sampling variation, or health-seeking and admission patterns. Therefore, interventions should not be sex-specific but should instead focus on known

modifiable risk factors, while further research is needed to clarify any potential sex-related differences in neonatal pneumonia risk across different setting

This study also found that neonates who weighed between 2.6–3.5) kgs at birth had a higher likelihood of being diagnosed with pneumonia as compared to those whose birthweight was not measured at birth. This could be because birthweight predicts the neonate's health, growth, psychosocial development, and chances of survival. The low birthweight brings about the formation of incomplete anti-immune substances that are more susceptible to infectious diseases, especially pneumonia. This is similar to findings from a meta-analysis study in India, which revealed that low birthweight increases the risk of neonatal pneumonia (22).

Similarly, a study conducted in China found that low birthweight neonates were more likely to develop neonatal pneumonia due to impaired immunity and underdeveloped organ systems (23). However, because our study did not specifically compare low birthweight neonates with normal birthweight neonates, the observed association may partly reflect differences in documentation practices or healthcare access among neonates whose birthweight was not recorded. These findings highlight the importance of strengthening neonatal assessment and documentation at birth, while also promoting maternal and child health education aimed at preventing adverse birth outcomes such as low birthweight.

This study found that neonates of caregivers with higher knowledge levels had a higher likelihood of being diagnosed with pneumonia compared to those with lower knowledge. This finding is counterintuitive, as caregiver knowledge is generally expected to be protective. A plausible explanation is that caregivers with higher knowledge are more likely to recognize early symptoms and seek timely healthcare, leading to increased detection and diagnosis of pneumonia. It is also possible that caregiver knowledge was acquired after experiencing illness in their neonates, creating a reverse causality effect. Similar patterns of increased healthcare utilization among more knowledgeable caregivers have been documented in child health studies, where higher caregiver awareness was associated with greater care-seeking and higher reported diagnosis rates rather than true increased disease incidence (see example evidence from integrated child health and care-seeking studies (26). In addition, studies on caregiver health literacy have shown that higher health literacy improves recognition of symptoms and increases health service utilization, which can influence observed disease prevalence in facility-based studies (27). While similar associations between caregiver knowledge and increased diagnosis have been observed in other settings, caution is needed in interpreting knowledge as a risk factor for disease. These findings highlight the importance of strengthening health education not only to improve preventive practices but also to enhance early recognition and timely care-seeking for neonatal illness.

The findings from our study indicated that neonates of participants whose common cooking fuel was electricity and gas were less likely to be diagnosed with pneumonia compared to those of participants who used charcoal. These findings are consistent with a study that was done in Worabe, which showed that use of unsafe sources of energy for cooking, such as charcoal, wood and biomass, increased the risk of occurrence of pneumonia in children (28). Similarly, a global analysis by the World Health Organization estimates that exposure to household air pollution is responsible for a substantial proportion of childhood

pneumonia cases in low- and middle-income countries due to high levels of indoor particulate matter and toxic pollutants (29). This is probably because unsafe means of energy for cooking lead to indoor air pollution, which increases susceptibility of the neonate to contracting pneumonia, unlike gas and electricity, which barely pollute the environment in the cooking place. These findings underscore the need for integrated interventions that go beyond health education to include promotion of clean energy adoption, improved household ventilation, and policies that enhance access to affordable and safer cooking technologies. Such approaches are critical in reducing indoor air pollution and, consequently, the burden of neonatal and childhood respiratory infections in low-resource settings.

Neonates from households where cooking was done in a separate kitchen had a higher likelihood of being diagnosed with pneumonia compared to those from households with a kitchen attached to the living room. This finding contrasts with evidence from southern Ethiopia, where cooking in an attached kitchen was identified as a risk factor for pneumonia (17). The inconsistency may reflect differences in household ventilation, kitchen structure, proximity of the child during cooking, and patterns of smoke dispersion within the household environment. It is also possible that in some settings, separate kitchens may still expose neonates to smoke if poorly ventilated or if infants are frequently brought into cooking areas. These findings highlight the need for context-specific household environmental assessments and interventions that go beyond kitchen location alone, focusing instead on reducing exposure of neonates to indoor air pollution through improved ventilation, safe childcare practices during cooking, and adoption of clean energy solutions.

Study strengths and limitations

The retrospective use of self-reported data introduced potential recall bias. However, this was minimized by restricting the recall period to the first seven days after birth. Social desirability bias may also have influenced responses on risk factors, but this was mitigated through assurances of anonymity and confidentiality. As a facility-based study conducted in public Health Centre IVs, the findings may not be generalizable to neonates who do not access these facilities or seek care elsewhere. In addition, reliance on register-based diagnoses may have led to possible over- or under-reporting of neonatal pneumonia, affecting accuracy. The relatively small sample size further limited the study's ability to robustly identify all associated risk factors. Despite these limitations, the study provides valuable context-specific insights into neonatal pneumonia and highlights important areas for intervention in similar settings.

Conclusion

Neonatal pneumonia remains relatively prevalent in Health Centre IVs in Wakiso district, with key associated factors including limited antenatal care attendance, low caregiver knowledge, household environmental exposures (such as charcoal use and cooking within living spaces), and gaps in birthweight measurement. Addressing this burden requires a multifaceted approach: strengthening antenatal care utilization and caregiver awareness of pneumonia risk factors; promoting safer cooking practices, including the use of cleaner energy sources and separate kitchens to reduce indoor air pollution; and ensuring routine measurement of neonatal birthweight for early risk identification. In addition, government and partner

organizations should implement targeted health education and behavior change interventions focusing on high-risk households, while future research should employ robust, large-scale and qualitative study designs to better understand contextual drivers and inform tailored, evidence-based interventions.

Declarations

Ethical considerations

All methods were performed in accordance with relevant guidelines and regulations, such as the 1964 Declaration of Helsinki. The study was approved by the Makerere University School of Public Health Research and Ethics Committee (MakSPH REC) protocol number 476. Written informed consent was obtained from all participants after explaining the nature of the study, potential risks and benefits, and how the data was to be used. Participants' privacy and confidentiality were protected throughout the study, and any personal or identity-specific information was kept secure.

Consent to Parental participate

Written informed consent was obtained from all mothers or primary caregivers before enrolment into the study. As the study involved neonates (children aged less than 28 days), informed consent was obtained from their parents or legally authorized caregivers on behalf of the neonates before conducting the interviews and reviewing the relevant medical records. Participation was voluntary, and participants were informed of the study objectives, procedures, potential risks and benefits, their right to decline or withdraw from the study at any time without affecting the care they or their infants received, and the measures taken to ensure confidentiality and anonymity of the information collected.

Consent for publish

Not applicable. The manuscript does not include any individual person's data

Clinical trial number

not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

The study received no funding

Author Contribution

NB conceptualized the idea, carried out research, analysed the data, and wrote the manuscript. ENJ and AK supervised NB, reviewed the proposal, dissertation, and manuscript. MA and DM revised the analysis and edited the manuscript.

Acknowledgement

We would like to thank the Wakiso district local government for granting us the administrative approval and all the Health Centres and participants that agreed to take part in this survey.

Availability of data and materials

The datasets generated and analyzed during this study are available from the corresponding author on reasonable request.

Code availability

This does not apply to this study.

Availability of data and materials

The datasets used and/or analysed during the study are available from the corresponding author upon reasonable request. All data generated or analysed during this study are included in this published article

References

1. WHO. Pneumonia in children. 2022.
2. UNICEF, Pneumonia. A Child dies of Pneumonia every 43 seconds. 2022.
3. Green RJ, Kolberg JM. Neonatal pneumonia in sub-Saharan Africa. Pneumonia (Nathan Qld). 2016;8:3.
4. Le Roux DM, Nicol MP, Vanker A, Nduru PM, Zar HJ. Factors associated with serious outcomes of pneumonia among children in a birth cohort in South Africa. PLoS ONE. 2021;16(8):e0255790.
5. Kiconco G, Turyasiima M, Ndamira A, Yamile OA, Egesa WI, Ndiwimana M, et al. Prevalence and associated factors of pneumonia among under-fives with acute respiratory symptoms: a cross sectional study at a Teaching Hospital in Bushenyi District, Western Uganda. Afr Health Sci. 2021;21(4):1701–10.
6. Imdad A, Mayo-Wilson E, Haykal MR, Regan A, Sidhu J, Smith A et al. Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. Cochrane database Syst reviews. 2022(3).
7. Wardlaw T, You D, Newby H, Anthony D, Chopra M. Child survival: a message of hope but a call for renewed commitment in UNICEF report. Reproductive health. 2013;10:64.

8. Abdel-Wahab F, Ghoneim M, Khashaba M, El-Gilany A-H. D. Abdel-Hady. Nosocomial infection surveillance in an Egyptian neonatal intensive care unit 2013.
9. Brenda L. Tesini. Neonatal Pneumonia. 2022.
10. Hooven TA, Polin RA. Pneumonia. Seminars in fetal & neonatal medicine. 2017;22(4):206 – 13.
11. WHO. Ending Preventable Child Deaths from Pneumonia and Diarrhoea by 2025. 2013:63.
12. UBOS. Wakiso District in Central Region Statistics 2016.
13. NPHC. Uganda Bureau of Statistics, Wakiso District 2024 [cited 2026 23/05/2026]. Available from: https://statistics.ubos.org/nphc/drilldown?subregion=11&district=113
14. Kish L. Sampling organizations and groups of unequal sizes. American sociological review. 1965:564 – 72.
15. Tumuhamye J, Sommerfelt H, Bwanga F, Ndeezi G, Mukunya D, Napyo A, Nankabirwa V, Tumwine JK. Neonatal sepsis at Mulago national referral hospital in Uganda: Etiology, antimicrobial resistance, associated factors and case fatality risk. PLoS ONE 2020;15(8).
16. Lamichhane A, Mishra A. Prevalence of Ventilator Associated Pneumonia in Neonates in A Tertiary Care Hospital in Western Nepal. J Nepal Med Association. 2019;57(216):84–7.
17. Solomon Y, Kofole Z, Fantaye T, Ejigu S. Prevalence of pneumonia and its determinant factors among under-five children in Gamo Zone, southern Ethiopia, 2021. Frontiers in pediatrics. 2022;10:1017386.
18. Pina JC, Moraes SA, Freitas ICM, Mello DF. Role of Primary Health Care in child hospitalization due to pneumonia: a case-control study. Rev Latinoam Enferm. 2017;25:e2892.
19. Al-Dalfi MHK, Al Ibraheem SAH, Al-Rubaye AKQ. The severity of pneumonia and its association with socio-demographic factors among children under five years old in Wasit governorate hospitals, Iraq. J public health Afr. 2023;14(8):2674.
20. Choudhury AM, Nargis S, Mollah AH, Kabir LM, Sarkar RN. Determination of risk factors of neonatal pneumonia. Mymensingh Med journal: MMJ. 2010;19(3):323–9.
21. Fadel SA, Ram U, Morris SK, Begum R, Shet A, Jotkar R et al. Facility delivery, postnatal care and neonatal deaths in India: nationally-representative case-control studies. 2015;10(10):e0140448.
22. Nair NS, Lewis LE, Dhyani VS, Murthy S, Godinho M, Lakiang T, et al. Factors Associated With Neonatal Pneumonia and its Mortality in India: A Systematic Review and Meta-Analysis. Indian Pediatr. 2021;58(11):1059–61.
23. Xu X, Deng Y, Han J, Wang J, Huang R, Zhao XJFP. Analysis of risk factors contributing to neonatal pneumonia in low birth weight neonates. 2025;13:1620077.
24. Zar HJ, Barnett W, Stadler A, Gardner-Lubbe S, Myer L, Nicol MPJTLRM. Aetiology of childhood pneumonia in a well vaccinated South African birth cohort: a nested case-control study of the Drakenstein Child Health Study. 2016;4(6):463–72.
25. Gezmu AM, Bulabula AN, Dramowski A, Bekker A, Aucamp M, Souda S et al. Laboratory-confirmed bloodstream infections in two large neonatal units in sub-Saharan Africa. 2021;103:201–7.
26. January WHOJWHOwhwwimcadeihA. Countdown to 2015: taking stock of maternal, newborn & child survival: decade report (2000–2010). 2012;4.

27. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ. Crotty KJAoim. Low health Lit health outcomes: updated Syst Rev. 2011;155(2):97–107.
28. Seramo1 Rk. SM, YW, Musa MohammedAli4. Determinants of pneumonia among children attending public health facilities inWorabe town. Scientifc Rep. 2022.
29. WHO. Household air pollution Geneva2025 [cited 2026 22/05/2026]. Available from: https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health