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Neonatal Mortality and Associated Factors among Neonates in Kiryandongo Refugee Settlement, Western Uganda

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ABSTRACT

Background: Death of a live-born baby within the first 28 days of life remains a critical global public health concern, particularly in low- and middle-income countries such as in sub-Saharan African, where refugee settlements often show higher varying neonatal mortality rates. This study aimed at assessing neonatal mortality rate and associated factors among neonates in Kiryandongo Refugee Settlement, Western Uganda.

Subjects and Method: The study used a facility based retrospective cross-sectional design involving all neonates (0-28days) admitted over a 5-year study period at Panyadoli Hospital. A total of 510 records of neonatal admissions selected using systematic sampling. Logistic regression analysis was used to determine the factors associated with neonatal mortality and odds ratio was used as a measure of association. All statistical tests were two-tailed and p-value less than 0.05 were considered significant.

Results: The neonatal death rate was 43 per 1,000 admissions. Neonatal mortality was significantly higher among mothers aged 25–34 years (aOR= 3.85; 95% CI= 1.74 to 8.90; p= 0.038) and ≥35 years (aOR= 7.88; 95% CI= 1.01 to 15.29; p= 0.049). It was also significant to those mothers delivering at home or in the community (aOR= 7.72; 95% CI= 2.04 to 31.45; p= 0.011), and those with pregnancy complications (aOR= 3.6; 95% CI= 1.93 to 8.14; p <0.001). Conversely, skilled birth attendance (aOR= 0.49; 95% CI= 0.21 to 0.69; p= 0.047) and an Apgar score of 4–6 at 1 minute (aOR= 0.12; 95% CI= 0.03 to 0.44; p= 0.002) were identified as protective factors.

Conclusion: This study found a high neonatal mortality rate of 43 deaths per 1,000 admissions, highlighting the urgent need to strengthen antenatal, intrapartum, and postnatal/postpartum maternal and neonatal care to improve neonatal survival.

Keywords: neonatal mortality, associated factors, neonates, refugee settlement, maternal health.

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BACKGROUND

Death of a live-born baby within the first 28 days of life remains a critical global public health concern, particularly in the low and middle-income countries. Although neonatal deaths have reduced by 44% since the year 2000, about half of (47%) of all deaths in children under 5 years of age occurred in first 28 days of life in 2022 (WHO, 2024). This highlights the urgent need for intensified efforts to achieve the 2030 SDGs target (3.2) aiming to reduce neonatal mortality per country to at least low as 12 deaths per 1000 live births (United Nations Development Programme, 2015).

Globally, 2.3 million of neonates die every year, translating to approximately 192,000 neonates' death per month and about 6,500 neonates' death every day (UNICEF, 2025). Despite global progress in neonate's survival, significant disparities persist across regions and countries. The highest neonatal mortality rate has been continuously reported in Sub-Saharan Africa at 27 per 1000, Southern Asia and central following at 21 per 1000 live births (UNICEF, 2025; WHO, 2024).

In high income countries like USA, the rate of neonates dying is relatively low at 3.27 per 1000 live births, a rate that has decreased from 3.84 in every year since 2016 (CDC, 2022), though higher compared to countries like Finland and Japan, with rates as low as 1.4 and 0.8 respectively (Ely & Driscoll, 2022; World Health Organization - Global Health Observatory, 2026). Western Europe recorded a neonatal mortality rate of 2.3 per 1000 live births in 2023 (Sartorius et al., 2024). Rates also differ between high income European countries, with neonatal mortality two-fold between low mortality and high mortality in Europe (Zeitlin et al., 2016). With noted excess neonatal mortality compared with top three ranging from 0.17 per 1000 in the Czech Republic to 1.82 per 1000 in Romania (Sartorius et al., 2024).

The likelihood of a neonatal death is over 10 times higher in Sub-Saharan African countries such as Mauritania, Ethiopia, and Chad and eight times higher in parts of Asia compared to high-income countries (Masaba & Mmusi-Phetoe, 2020; UNICEF, 2025). This disparity reflects deep-rooted inequalities in access to quality maternal and newborn healthcare services, including skilled birth attendance, emergency obstetric care, and postnatal care. Across countries, the risk can be up to 65 times higher in the highest mortality country than in the lowest mortality country. For example, African countries with weak health systems can experience rates exceeding 40 deaths per 1,000 live births. The situation is out of hands due to factors such as poverty, malnutrition, inadequate health infrastructure, and limited health workforce.

Although some refugee settlements show lower neonatal mortality than host communities do, the burden is still too high. A study on burden of neonatal mortality in refugees under UNCHR across world, Uganda inclusive, found neonatal mortality range 12 to 56 neonatal deaths per 1000 live births with more of neonatal death reported in communities (Tappis et al., 2021). The findings highlight the continued vulnerability of newborns in refugee communities despite the presence of humanitarian interventions. Inadequate access to skilled birth attendants, limited neonatal care and delays in seeking neonatal health care worsen this burden more (Verschuuren et al., 2024). Strengthening community-based health systems and ensuring consistent access to maternal and newborn care services are essential in reducing newborn death in refugee settlement (UNHCR, 2022).

Uganda is one of the major refugees and an asylum seeker receiving country from about 34 countries. Currently, Uganda refugee population is estimated at 1829,606, with more refugees from South Sudan, Sudan and DRC compared to other countries (UNHCR, 2025), with almost all the refugees' settlements located in extremely rural area of Uganda. The current national neonatal mortality rate is estimated at 22 per 1000 live births (Kyasimire et al., 2024), about twice the SDGs 3.2 target of 12 per 1000live birth by 2030 (United Nations Development Programme, 2015) and a half the under-five mortality rate of 46 per 1,000 live births.

Studies show that neonatal mortality rates are higher in rural areas than in urban areas (Kananura et al., 2016; Tappis et al., 2021). According to studies conducted in East Africa, including Uganda, respiratory distress syndrome, prematurity, neonatal infections (sepsis), congenital anomalies, and other conditions such as birth trauma and anemia are the major causes of neonatal deaths (Desalew et al., 2020; Egesa et al., 2020; Kyasimire et al., 2024). The underlying causes of neonatal mortality include extreme maternal age, poor maternal and child healthcare service utilization, and high parity (Egesa et al., 2020; Engelhardt et al., 2022; Kananura et al., 2016). While antenatal care utilization, postnatal care attendance, proper newborn care practices by mothers and community health awareness practices have been reported to reduce neonatal mortality in refugee settings (Kananura et al., 2016; UNHCR, 2022), the mortality rate remains high. The lack of context-specific data on neonatal mortality and its determinants in humanitarian settings—particularly in refugee settlements like Kiryandongo Refugee Settlement in Uganda and other low- and middle-income countries—has constrained efforts to reduce neonatal deaths (Desalew et al., 2020; Tappis et al., 2021). This gap undermines the need for timely, conceptual evidence-based interventions needed to address the neonatal deaths (Austin et al., 2014).

This study therefore aims to determine the burden of neonatal mortality and identify the associated factors for neonatal mortality among neonates in Kiryandongo region refugee settlements.

SUBJECTS AND METHOD

1. Study Design

The study used a facility-based retrospective cross-sectional design to determine neonatal mortality and the associated factors among neonates admitted between June 1, 2020, to June 30, 2025, in Panyadoli Hospital, a government hospital within Kiryandongo refugee settlement, located in Bweyale Town Council, Kiryandongo District, western Uganda, which is about 237.8 km from Kampala.

2. Population and Sample

The study included both refugee and host community neonates admitted between June 1, 2020, and June 30, 2025, regardless of their outcomes. The sampling frame consisted of all neonatal admission recorded in the neonatal admission unit register at Neonatal Intensive Care Unit of Panyadoli Hospital, as well as in the Health Management Information System database during the study period (Ministry of Health Knowledge Management Portal, 2024). Yamane's formula was used to determine the study sample size, since the target population was finite and its size was known (Israel, 1992). Level of precision was set at 0.05 and the confidence level at 95%. Additionally, they added 10% to account for missing or incomplete data.

$$n = \frac{N}{1+N(e)^2}$$

"n" is sample size, "N" is population, number of neonates for the last five years is 8,200 (Ministry of Health Knowledge Management Portal, 2024), 4"e" is precision (0.05) or level of confidence 95%. After considering 10%: n (sample size) =510 participants.

The researchers used a systematic sampling technique. The sampling interval was obtained by dividing the total number of neonatal admission (8200) during study period by the sample size (510), yielding 16. Using a simple random lottery method (Cubitt et al., 1998), a random starting point between 1 to 16 was selected. Using pieces of papers, numbers 1 to 16 were written on separate papers, mixed, and a number was drawn blindly from the mixed papers. This number corresponded to the first neonate selected from the admission neonatal unit register. Thereafter, every sixteenth neonate was selected from register until the sample size was attained regardless of outcome, if the neonate met the study's inclusion criteria.

The inclusion criteria comprised all neonates admitted to Panyadoli Hospital in the Kiryandongo Refugee Settlement between June 1, 2020, and June 30, 2025, regardless of their health outcomes. Neonates with incomplete medical records or without a documented admission diagnosis in either the admission forms or the neonatal admission register were excluded.

3. Study Variables

Neonatal mortality served as the dependent variable in this study. The team defined it as the death of a live-born infant within 28 days after birth. It was measured as a categorical variable with two outcomes, alive or dead. The independent variables of study included; maternal related factors and neonatal clinical related factors.

The maternal-related variables included maternal age (15–19, 20–24, 25–34, and ≥35 years), parity (categorized by number of births), mode of transport to the health facility (motorcycle, car, or walking), place of delivery (health facility or home/ community), birth attendant (skilled or unskilled), mode of delivery (normal vaginal delivery or caesarean section), number of antenatal care (ANC) visits (none, 1–3, or ≥4), timing of ANC initiation (categorized by gestational weeks), and mode of ANC service delivery (facility or community). Additional variables included gestational age (<37, 37–40, or >40 weeks), pregnancy complications (yes/no), maternal illness during pregnancy (yes/no), use of iron and folic acid supplementation (yes/ no/unknown), and receipt of intermittent preventive treatment (IPT) (yes/no).

The neonatal clinical variables included sex (male/female), birth weight (<2.5 kg, 2.5–3.5 kg, or >3.5 kg), gestational number (singleton, twin, or multiple birth), Apgar score (0–3, 4–6, or ≥7), umbilical cord cutting method (sterile or non-sterile), and neonatal diagnosis, which was recorded as a multiple-response variable.

4. Operational Definition of Variables

Neonatal mortality is the probability of dying within the first 28 days of life.

A refugee settlement refers to a designated area where humanitarian agencies and host governments offer refugees shelter, basic services, and protection, often on a temporary or semi-permanent basis.

Skilled Birth Attendant is an accredited health professional such as a midwife, nurse or doctor who has been educated and trained in profiency in the skills needed to manage normal pregnancies, childbirth and the immediate postnatal period, and in identification, management and referral of women and neonates for complication (WHO, 2018).

Pregnancy Complications are health conditios that are related to or arise due to pregnancy.

Maternal Health refers to health of a woman during pregnancy, childbirth and postnatal period.

Apgar Score is a standardized assessment tool for assessing neonates' status immediately after birth, and the response to resuscitation efforts.

Gestational Age is the number of weeks from the first day of pregnant patients last normal menstrual period to the date of delivery.

5. Study Instruments

The technique for data collection used in the study was document / records review. The study extracted data retrospectively from neonatal medical records. Neonatal admission registers and admission medical charts served as the primary data sources. Data extraction involved the use of a standardized tool adopted from the facility's Neonatal Intensive Care Unit (NICU) admission protocol guide and Uganda Ministry of Health guidelines (Ministry of Health the Republic of Uganda, 2022). The research team sought and obtained permission from the district and facility authorities to access this information.

A document or records review checklist was a tool designed to capture information extracted from the Neonatal Intensive Care Unit (NICU) admission registers. The checklist contained a predefined set of response options to guide data extraction, and the use of standardized items made the checklist easier to use and allowed quick aggregation, quantification, and analysis of the data (Ranganathan & Caduff, 2023). The data collected focused on the biodata of the neonates, maternal-related factors, neonatal clinical-related factors, and neonatal outcomes.

To ensure the data quality and validity, the research team adopted the checklist from the facility's Neonatal Intensive Care Unit (NICU) admission protocol guide and the Uganda Ministry of Health guidelines (Ministry of Health the Republic of Uganda, 2022) . They also incorporated input from pediatricians and neonatologists in the NICU department and gynecologists in the maternity department to ensure the content validity of the structured data collection tool.

The team conducted pre-testing (pilot testing) in a non-selected health facility within Kiryandongo district. The pretest assessed how well the checklist content aligned with the study objectives and whether the items were clear. The team analyzed the extracted data and scored each item's validity using the Content Validity Index (CVI) (Dalawi et al., 2023).

Five experts rated each item for relevance using a 4-point scale: 1 = Not relevant, 2 = Somewhat relevant, 3 = Quite relevant, and 4 = Highly relevant. For each item, the team counted how many experts rated it as three or four, then divided that number by the total number of experts. They excluded items with a score below 0.70, revised items that scored between 0.70 and 0.78, and retained items that scored above 0.78 as relevant to the study objectives (Dalawi et al., 2023).

Reliability was assessed through a Cronbach's alpha coefficient (Taber, 2018) , to determine the internal consistency of the items in the adopted checklist. STATA Version 14 was used to assess reliability during the data cleaning phase after a pretest, and a Cronbach's alpha value of 0.70 or higher was considered acceptable for indicating good internal consistency (Taber, 2018).

The team revised items that scored between 0.70 and 0.78, and retained items that scored above 0.78 as relevant to the study objectives (Dalawi et al., 2023). They discussed the revised items with subject experts to ensure clarity and relevance. If the revised items met the set threshold upon re-evaluation, the team included them in the final checklist.

6. Data Analysis

The research team developed a data management manual that outlined detailed procedures for data extraction, entry, storage, and cleaning. The team imported data from Microsoft Excel into STATA version 14. They analyzed descriptive statistics using frequency distribution tables and percentages. Neonatal mortality was defined as a dichotomous variable. To identify the association between each independent variable and neonatal mortality, a bivariate analysis was used.

Based on the specified selection criteria, the team included all variables with a p-value less than 0.25 from the bivariate analysis in the multivariable analysis. They assessed the model's goodness of fit using Pregibon's goodness-of-link test (Qiu et al., 2019). A p-value greater than 0.05 indicated that the logit link was appropriate, thus validating the logistic regression model.

The team computed crude odds ratios and adjusted odds ratios (AORs) at a 95% confidence interval (CI). In the multivariable analysis, variables with a p-value less than 0.05 were considered significantly associated with neonatal mortality.

7. Research Ethic

The research team obtained ethical clearance from the Institutional Ethics Review Board of Afromed Academy of Medical Research and Innovation with reference number ASERB/2025/004. A support letters to facility administrators to request permission before starting the study was provided. The team did not seek informed consent from study participants because the study involved reviewing medical records of previously admitted neonates. We maintained strict confidentiality of all participant information throughout the study. Data was collected using identification codes instead of participant names. Only the research team accessed the raw data. The team securely stored interview responses in password-protected digital files and in locked cabinets for paper-based documents. Electronic data was archived and limited access to the investigator and supervisor for academic purposes only.

RESULTS

1. Sample Characteristics

The results showed most neonates were admitted between 0-6 days (84.7%), with half having a normal admission weight 2.5 – 3.5kgs (67.1%) and nearly half of neonates with normal admission temperature in degrees Celsius 36.6-37.5 (47.3%). Most of the mothers of the respondents had their date of prenatal visits in weeks 13-20 (51.8%).

Table 1. Neonates and maternal characteristics

Variables	Frequency (n)	Percentage (%)
Date of admission of neonate (days)		
0-6 days	432	84.7
7-28 days	88	17.3
Admission weight of neonate (kgs)		
2.5-3.5	342	67.06
<2.5	116	22.72
3.5	52	10.20
Admission temperature of neonate (°C)		

Variables	Frequency (n)	Percentage (%)
< 36.5	157	30.78
36.5 to 37.5	241	47.25
>37.5	112	21.96
Prenatal visits (weeks)		
<13	144	28.2
13-20	264	51.8
>20	102	20

Figure 1 summarizes neonatal outcomes after admission. Of the 510 neonates admitted, the overwhelming majority survived (488, 95.7%), while a small fraction died (22, 4.3%).

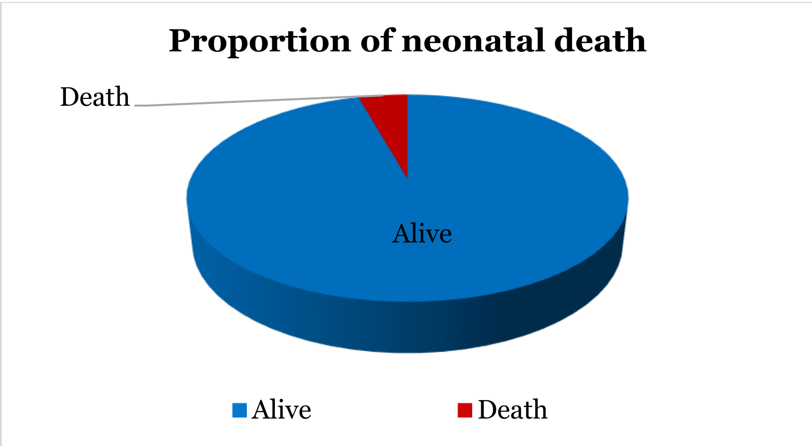

Figure 1. Proportion of neonatal death among neonatal admissions

2. Bivariate analysis

The results in Table 2, showed most mothers were aged between 20–34 years (34.1% each), and had 2–4 parity (47.3%). The overwhelming majority delivered at a health facility (97.3%), delivered by a skilled health worker (96.9%), and the predominant mode of delivery was normal vaginal delivery (76.5%). Most mothers had 1–3 antenatal visits attended (64.3%), and their first antenatal visit occurred mostly at 13–20 weeks (51.4%).

Table 2. Maternal related factors associated with neonatal mortality

Variables	Neonatal mortality		COR (95% CI)	p
	Dead (%)	Alive (%)		
Mother's age				
15-19	6(5.0)	114(95.0)	1.0	
20-24	6(3.4)	168(96.6)	2.57(0.74-8.90)	0.137
25-34	5(2.9)	169(97.1)	3.78(1.09-13.06)	0.025
≥35 yrs	5(11.9)	37(88.1)	4.57(1.26-16.59)	0.021
Parity (including this pregnancy)				
1	8(4.6)	163(95.3)	1.0	
2-4	7(3.0)	228(97.0)	1.47(0.52-4.18)	0.470
>4	7(6.7)	97(93.3)	2.35(0.80-0.88)	0.119

Variables	Neonatal mortality		COR (95% CI)	p
	Dead (%)	Alive (%)		
Mode of transport to health				
facility	5(16.7)	25(83.3)	1.0	
Ambulance	7(10.8)	58(89.2)	2.00(0.04-3.98)	0.144
Foot/walking	5(1.2)	400(98.8)	3.28(0.911-5.92)	0.305
Motorcycle / boda-boda	5(50.0)	5(50.0)	3.00(0.47-6.27)	0.266
Unknown				
Place of delivery				
Facility	15(3.0)	481(97.0)	1.0	
Home/community	7(50.0)	7(50.0)	11.07(2.98-31.99)	<0.001
Delivery attended by				
Nonskilled health worker	8(50.0)	8(50.0)	1.0	
Skilled health worker	14(2.8)	480(97.2)	0.53(0.110-0.99)	<0.001
Mode of delivery				
Caesarean section	5(4.2)	115(95.8)	1.0	
Normal vaginal	17(4.4)	373(95.6)	1.05(0.39-2.90)	0.928
Antenatal visits attended				
1-3	8(4.9)	155(95.1)	1.0	
4 or more	9(2.7)	319(97.3)	2.92(0.99-4.01)	0.431
None	5(26.3)	14(73.7)	2.66(0.75-4.76)	0.123
Gestational Age at first				
antenatal visit	9(6.4)	132(93.6)	1.0	
≤12 weeks	5(1.9)	257(98.1)	1.185(0.44-3.18)	0.736
13-20 weeks	8(7.5)	99(92.5)	1.15(0.33-3.00)	0.214
>20 weeks				
Mode of Antenatal service				
delivery	6(46.2)	7(53.8)	1.0	
Community	16(3.2)	481(96.8)	0.14(0.10-1.13)	0.189
Facility				
Gestational age				
<37wks	9(8.1)	102(91.9)	1.0	
37- 40 wks.	5(1.6)	316(98.4)	1.29(0.48-3.52)	0.612
>40wks	8(10.3)	70(89.7)	7.29(2.29-22.74)	0.001
Complications during				
pregnancy	16(3.2)	480(96.8)	1.0	
No	6(42.9)	8(57.1)	3.50(1.98-8.48)	<0.001
Yes				
Maternal illness during				
pregnancy	5(1.5)	330(98.5)	1.0	
No	17(9.7)	158(90.3)	2.10(0.57-6.59)	0.091
Yes				
Mother took folate				
No	12(9.9)	109(90.1)	1.0	
Unknown	5(13.2)	33(86.8)	0.13(0.10-2.38)	0.615
Yes	5(1.4)	346(98.6)	0.90(0.52-2.98)	0.971
Mother took Iron				
No	6(24.0)	19(76.0)	1.0	
Unknown	5(13.9)	31(86.1)	0.18(0. 03-1.24)	0.412
Yes	11(2.4)	438(97.6)	0.16(0.02-1.48)	0.201
Mother take Intermittent				
Preventive Treatment (IPT)				
Fansidar	7(25.0)	21(75.0)	1.0	
No	5(13.5)	32(86.5)	0.37(0.12-2.20)	0.067

Variables	Neonatal mortality		COR (95% CI)	p
	Dead (%)	Alive (%)		
Unknown	10(2.2)	435(97.8)	0.25(0.15-1.46)	0.111
Yes				

Antenatal care was predominantly received at the facility (97.5%), and most deliveries occurred at a gestational age of 37–40 weeks (62.9%). Nearly all mothers reported no pregnancy complications (97.3%), though among those with complications, pre-labor rupture of membranes (71.4%) was most common. Regarding illnesses, about two-thirds had no maternal illness (65.7%), but among those who did, malaria (48.0%) was the most common. On preventive interventions, most mothers reported taking iron (88.0%), IPT Fansidar (87.3%), and folate (68.8%).

At bivariate analysis, neonatal mortality was significantly higher among neonates born to mothers aged 25–34 years (COR = 3.78; 95% CI: 1.10 to 13.06) and ≥35 years (COR = 4.57; 95% CI: 1.26 to 16.59), those delivered at home or in the community (COR = 11.07; 95% CI: 2.98 to 31.99), post-term neonates (>40 weeks) (COR = 7.29; 95% CI: 2.29 to 22.74), and neonates of mothers with pregnancy complications (COR= 3.50; 95% CI: 1.98 to 8.48). Conversely, neonatal mortality was significantly lower among babies delivered by a skilled health worker (COR = 0.53; 95% CI: 0.11 to 0.99, p < 0.001).

The Table 3 shows that most neonates were admitted with a normal body temperature of 36.5–37.5°C (47.1%), had an admission weight of 2.5–3.5 kg (56.3%), and were admitted within the first 0–6 days of life (89.2%). In terms of birth weight, most also weighed 2.5–3.5 kg (66.8%), and the majority were male (59.4%). Nearly all were singletons (93.3%) and had a good Apgar score at 1 and 5 minutes (81.0% and 94.9%, respectively) and most neonates umbilical cords were cut with a non-sterile or clean blade/scissors (54.7%). The leading diagnosis at admission was sepsis/infection (53.9%), highlighting infection as the most common neonatal health problem.

Table 3. Neonatal clinical related factors associated with neonatal mortality

Variables	Neonatal mortality		COR (95% CI)	p
	Dead (%)	Alive (%)		
Admission temperature of neonate (°C)				
<36.5	9(6.0)	142(94.0)	1.0	
36.5 to 37.5	6(2.5)	234(97.5)	0.98(0.36-2.73)	0.979
>37.5	7(5.9)	112(94.1)	2.44(0.80-7.42)	0.117
Admission weight				
<2.5kgs	11(8.9)	113(91.1)	1.0	
2.5-3.5kgs	5(1.7)	282(98.3)	0.66(0.24-1.86)	0.435
>3.5kgs	6(6.1)	93(93.9)	3.64(0.80-7.20)	0.636
Age at admission				
0-6 days	15(3.3)	440(96.7)	1.0	
7-28 days	7(12.7)	48(87.3)	2.28(0.66-4.01)	0.223
Birth weight				
<2,500 g	10(8.8)	103(91.2)	1.0	

Variables	Neonatal mortality		COR (95% CI)	p
	Dead (%)	Alive (%)		
2,500-3,500 g	6(1.8)	335(98.2)	1.24(0.42-3.59)	0.697
>3,500 g	6(10.7)	50(89.3)	3.70(0.80-8.59)	0.101
Gender of baby				
Female	6(2.9)	201(97.1)	1.0	
Male	16(5.3)	287(94.7)	1.87(0.72-4.85)	0.200
Number of gestations at birth				
Singlet	16(3.4)	460(96.6)	1.0	
Twins	6(17.6)	28(82.4)	6.16(2.24-16.96)	<0.001
Apgar score at 1 min				
0-3	6(35.3)	11(64.7)	1.0	
4-6	5(6.2)	75(93.8)	0.05(0. 02-0.16)	<0.001
7or more	11(2.7)	402(97.3)	0.41(0.14-1.40)	0.108
Apgar score at 5 min				
4-6	7(26.9)	19(73.1)	1.0	
7or more	15(3.1)	469(96.9)	0. 29(0.13-1.24)	0.089
Method of neonate's cord cutting				
Non- sterile/clean blade/scissors	17(6.1)	262(93.9)	1.0	
Sterile blade/scissors	5(2.2)	226(97.8)	0.34(0.12-0.94)	0.037

At bivariate analysis, neonatal mortality was significantly higher among neonates among twins (COR = 6.16; 95% CI: 2.24 to 16.96; p < 0.001). Conversely, neonatal mortality was significantly lower among babies with an Apgar score of 4–6 at 1 minute (COR = 0.05; 95% CI: 0.02 to 0.16; p < 0.001), and neonates whose umbilical cord was cut using a sterile blade or scissors (COR = 0.34; 95% CI: 0.12 to 0.94; p = 0.037).

3. The result of multivariate analysis

Table 4 presents the adjusted estimates of the variables that were significant at the multivariate level. After adjusting for potential confounders, mothers aged 25–34 years were 3.85 times more likely to experience neonatal mortality compared to those aged 15–19 years (aOR= 3.85; 95% CI: 1.74 to 8.90; p = 0.038), and the association was statistically significant.

Similarly, mothers aged above 35 years were 7.88 times more likely to have neonatal mortality compared to those aged 15–19 years (aOR= 7.88; 95% CI: 1.01 to 15.29; p = 0.049), and this association was statistically significant.

In relation to the place of delivery, mothers who delivered in the home/ community setting were 7.72 times more likely to experience neonatal mortality compared to those who delivered in a health facility (aOR= 7.72; 95% CI: 2.04 to 31.45; p= 0.011), and this association was statistically significant.

Pregnancy complications also showed a strong association. Mothers who experienced complications during pregnancy were 3.67 times more likely to have neonatal mortality compared to those without complications (aOR= 3.67; 95% CI: 1.93 to 8.13; p= 0.001), and the association was statistically significant.

Regarding delivery attendance, mothers whose births were attended by a skilled health worker were 0.49 times less likely to experience neonatal mortality compared to those attended by unskilled health workers (aOR= 0.49; 95% CI: 0.21 to

0.70; p= 0.047), and this association was statistically significant.

Neonates with an Apgar score of 4–6 at 1 minute were 0.115 times less likely to die compared to those with a score of 0–3 (aOR= 0.11; 95% CI: 0.03 to 0.44; p= 0.002), and this association was statistically significant.

Table 4. Multivariable analysis of factors associated with neonatal mortality

Variables	cOR (95% CI)	p	aOR (95% CI)	p
Mothers age				
15-19 years old	1.0		1.0	
20-24 years old	2.57(0.74-8.90)	0.137	6.11(0.52-17.07)	0.151
25-34 years old	3.78(1.09-13.06)	0.025	3.85(1.74-8.90)	0.038
≥35 years old	4.57(1.26-16.59)	0.021	7.88(1.01-15.29)	0.049
Place of delivery				
Facility	1.0		1.0	
Home/community	11.07(2.98-31.99)	<0.001	7.72(2.04-31.45)	0.011
Gestational age				
<37 weeks	1.0		1.0	
37- 40 weeks	1.29(0.48-3.52)	0.612	2.53(0.48-3.93)	0.128
>40 weeks	7.29(2.29-22.74)	0.001	1.90(0.15-3.61)	0.616
Complications during pregnancy				
No	1.0	<0.001	1.0	
Yes	3.50(1.98-8.48)		3.67(1.93-8.13)	<0.001
Number of gestations at birth				
Singlet	1.0		1.0	
Twins	6.16(2.24-16.96)	<0.001	5.62(0.64-9.61)	0.733
Delivery attended by				
Nonskilled health worker	1.0		1.0	
Skilled health worker	0.53(0.11-0.99)	<0.001	0.49(0.21-0.69)	0.047
Apgar score at 1 min				
0-3	1.0		1.0	
4-6	0.05(0. 02-0.16)	<0.001	0.11(0.03-0.44)	0.002
7or more	0.41(0.14-1.40)	0.108	0.59(0.19-1.87)	0.374
Method of cord cutting				
Non-sterile/clean blade/scissors	.01		1.0	
Sterile blade/scissors	0.34(0.12-0.94)	0.037	0.25(0.02-2.79)	0.263

DISCUSSION

1. The prevalence of neonatal mortality

This study found that the neonatal mortality rate was 43 per 1,000 admissions. This is probably because many neonates are born to mothers with limited access to timely and adequate antenatal care, delivery at home or in poorly equipped facilities, and delays in seeking skilled care during labor and the immediate postnatal period. This finding is consistent with studies conducted in similar low- and middle-income countries, where neonatal mortality rates ranged between 30 and 50 per 1,000 live births, particularly in settings with limited access to quality maternal and neonatal healthcare services (Mugisha et al., 2020; Waiswa et al., 2010; Zietsch et al., 2010).

Similarly, research in Uganda and other sub-Saharan African countries has documented comparable neonatal mortality rates, attributing this to factors such as late initiation of antenatal care, low facility-based deliveries, and suboptimal newborn care practices (Nanyonjo et al., 2015; Okello et al., 2022). In contrast, studies in high-income countries such as Sweden and Canada report neonatal mortality rates below 5 per 1,000 live births (Lawn et al., 2014; Liu et al., 2015). These differences are likely due to stronger health system capacity, universal access to skilled birth attendants, routine postnatal follow-up, and comprehensive maternal and neonatal health programs. This aligns with WHO-recommended interventions for neonatal survival, including essential newborn care, early breastfeeding, skilled birth attendance, and prompt management of complications (WHO, 2016). Therefore, targeted interventions aimed at improving antenatal care utilization, increasing facility-based deliveries, strengthening neonatal care services, and promoting maternal preventive health measures could substantially reduce neonatal mortality in the study setting.

2. Maternal related factors associated with neonatal mortality

This study found that mothers aged 25–34 years were 3.8 times more likely to experience neonatal mortality compared to those aged 15–19 years, and mothers aged above 35 years were 7.88 times more likely to experience neonatal mortality compared to those aged 15–19 years. Advanced maternal age is associated with obstetric risks such as preeclampsia, gestational diabetes, chromosomal abnormalities, and complications during labor, all of which can negatively affect neonatal survival.

Similar patterns have been observed in Uganda, Kenya, and Ethiopia (Kumar et al., 2021; Musoke et al., 2019). Globally, higher neonatal mortality among older mothers has also been reported in LMICs due to increased maternal-fetal complications (Liu et al., 2015; WHO, 2016). However, in high-income settings, with universal access to prenatal care and advanced obstetric interventions, maternal age has a smaller impact on neonatal outcomes (Villar et al., 2021). Evidence-based interventions such as regular antenatal monitoring, early detection and management of maternal complications, and appropriate birth planning are essential to mitigate age-related neonatal risks.

Mothers who delivered at home or in community settings were 7.72 times more likely to experience neonatal mortality compared to those who delivered in health facilities. Home deliveries often lack skilled attendants, sterile equipment, and timely emergency interventions, consistent with trends across sub-Saharan Africa (Kumar et al., 2021; Musoke et al., 2019).

International evidence confirms that facility-based deliveries are strongly associated with reduced neonatal mortality due to access to skilled care, emergency obstetric services, and immediate newborn interventions (Campbell et al., 2016; Lawn et al., 2014; Moxon et al., 2015). Community-based programs involving trained traditional birth attendants or midwives have also shown benefits where facility access is limited, but comprehensive skilled coverage remains more effective (Mannah et al., 2014). Interventions such as strengthening referral systems, improving transport to facilities, and scaling up skilled birth attendance are critical in LMIC contexts.

Mothers who experienced pregnancy complications were 3.67 times more likely to have neonatal mortality. Complications such as preeclampsia, antepartum hemorrhage, maternal infections, and gestational diabetes compromise fetal well-being and increase neonatal risk (Musoke et al., 2019). Globally, complications during pregnancy are consistently identified as major predictors of neonatal mortality, and interventions such as routine antenatal screening, timely management of maternal infections, and treatment of hypertensive disorders significantly improve neonatal outcomes (Villar et al., 2021; WHO, 2016). Rapid referral of high-risk pregnancies and integration of maternal-fetal surveillance into primary healthcare are evidence-based strategies to reduce neonatal deaths.

Births attended by skilled health workers were 0.48 times less likely to result in neonatal mortality compared to those attended by unskilled health workers. Skilled birth attendants can promptly manage complications, perform neonatal resuscitation, and provide immediate postnatal care (Campbell et al., 2016; Moxon et al., 2015). Internationally, skilled birth attendance has been a cornerstone of neonatal survival programs, with countries achieving low neonatal mortality rates often reporting near-universal skilled attendance and access to emergency obstetric care (Kruk et al., 2016; Lawn et al., 2014). Interventions must combine skilled personnel with facility readiness, essential equipment, and efficient referral systems to achieve maximal impact.

3. Neonatal clinical related factors associated with neonatal mortality

This study found that neonates with an Apgar score of 4–6 at 1 minute were 0.11 times less likely to die compared to those with a score of 0–3. This is probably because higher Apgar scores reflect better physiological adaptation immediately after birth, including effective respiration, heart rate, and muscle tone, which are critical for early neonatal survival. This finding is consistent with studies that have reported that low 1-minute Apgar scores are strongly associated with increased risk of neonatal mortality and adverse outcomes (Okemo et al., 2021).

However, although neonates with an Apgar score of 7 or more at 5 minutes were 0.09 times less likely to die compared to those with low Apgar scores. This association was not statistically significant. This pattern shows inconsistent with the clinical expectations which indicates neonates with higher Apgar score of 7 or more have higher odds of neonatal survival compared to neonates with lower Apgar score (Asadollahi et al., 2024; Cnattingius et al., 2020). This deviation in clinical pattern can be explained by a very small number of neonatal deaths among neonates with Apgar score 7 or more, leading to low statistical power and a wide confidence interval (Ranganathan et al., 2024; Serdar et al., 2021).

Studies have found that a good 5-minute Apgar score is protective against neonatal death because it indicates effective resuscitation and continued stabilization of the neonate, significantly reducing the risk of early death (Lawn et al., 2014; Lee et al., 2021). However, some studies have found that even neonates with moderate Apgar scores can experience mortality due to underlying conditions such as congenital anomalies or infections (Kumar et al., 2021) (Kumar et al., 2021). The differences could be because of variations in the quality of neonatal resuscitation, availability of skilled personnel, and facility resources across different settings. Evidence-based interventions including standardized neonatal resuscitation protocols, timely monitoring, and early treatment of at-risk neonates are essential to improve survival outcomes.

This study used a facility-based retrospective cross-sectional design and relied on document and records review. Consequently, the findings depended on the accuracy, completeness, and consistency of existing records. The exclusion of neonatal records with missing, inaccurate or incomplete information may have introduced information bias. Retrospective data are prone to missing, incomplete, or misclassified entries, potentially affecting the reliability of the findings. Being cross-sectional, the study could only identify associations and not causal relationships between risk factors and neonatal mortality. Additionally, the results may have limited generalizability beyond the study facility, as neonatal outcomes in other hospitals or community settings may differ due to variations in health service quality and population characteristics.

Furthermore, certain factors influencing neonatal outcomes, such as maternal behaviors, socio-economic conditions, and home-based care practices, were not captured in the records and could not be assessed, introducing potential residual confounding. Recognizing these limitations enhances transparency and underscores the need for prospective studies to validate these findings.

The neonatal mortality rate in Kiryandongo Refugee Settlement was relatively low at 43 per 1,000 deliveries, with most neonates surviving admission. Mortality was significantly associated with advanced maternal age (25–34 and ≥35 years), home or community delivery, and pregnancy complications, while skilled birth attendance was protective. Among neonatal factors, a low Apgar score at 1 minute was strongly associated with mortality. The findings are relevant to similar refugee healthcare settings.

Based on the study findings, the following contextual and targeted specific actions are recommended to address factors associated with neonatal mortality in Kiryandongo Refugee Settlement and a similar refugee setting. Strengthening individualized counseling and close follow-up for mothers through community health workers to improve birth preparedness and early complication recognition, intensify community sensitization and provide incentives (like transport support or maternal care kits), andenforcing structured antenatal care (ANC) protocols with regular screening and clear referral pathways for timely management of high-risk pregnancies. With some factors providing protective component to neonatal death such as skilled birth attendance should be expanded and support skilled birth attendance through continuous training, supervision, and deployment of qualified midwives to underserved areas. Additionally, intervention to address Low Apgar Score at 1 Minute should focus on equipping health facilities with neonatal resuscitation supplies and ensure regular emergency response training for maternity staff.

The study further highlights area for future research. Further studies are required to assess the effectiveness of interventions such as increased facility-based deliveries, and maternal supplementation in reducing neonatal mortality. There is also a need to investigate the circumstances surrounding pregnancy complications among high-risk mothers and evaluate whether previous interventions were implemented and effective.

AUTHOR CONTRIBUTION

All authors made substantial contributions to the conceptual and design draft for study and acquisition of data. I took part in drafting of articles, analysis and interpretation and critically revising and gave it for its final publication and agreed to be accountable of all aspects of the work in this study.

CONFLICT OF INTEREST

There is no conflict of interest.

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