BMC Pediatrics

RESEARCH

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Prevalence and factors associated with neonatal mortality at the neonatal intensive care unit at St. Mary's Hospital Lacor, Northern Uganda

Nicholas Aguma[1*], Steven Ekak[1], Lambert Emetu[1], Samson Ojok[1] and Peter Akera[1]

Abstract

Background Worldwide, neonatal mortality is a major public health burden especially in the developing countries. Several factors are associated with neonatal mortality at the neonatal intensive care unit (NICU). The aim of this study was to determine the prevalence and factors associated with neonatal mortality among neonates admitted to the NICU at St. Mary's Hospital Lacor in Northern Uganda.

Method The study collected quantitative data through retrospective descriptive review of records of 423 systematically sampled neonates admitted to the NICU between January 1st 2023 and December 31st 2023. Socio demographics, pregnancy related and neonatal variables of mothers and the neonates admitted to the NICU were entered in a pre-tested data abstraction tool adapted and modified from a similar study. Neonatal mortality was described as a proportion of the total number of neonates who were admitted. Logistic regression analyses using odds ratios with 95% confidence interval (CI) were used to assess the association between possible factors associated with neonatal mortality. An adjusted odds ratio (aOR), namely an odds ratio (OR) that has been adjusted to account for other predictor variables, is provided. Data was analysed using SPSS 27.0 statistical software (SPSS, Inc., Chicago, IL, USA).

Results There were 74 (17.49%) neonatal deaths. 70.27% of the neonatal deaths were early neonatal deaths. Preterm deaths contributed over 81.10% to the overall mortality.

Preterm birth (aOR = 3.81, 95% CI 1.14 – 12.78), low APGAR at 5 min (aOR = 4.52, 95% CI 2.04 – 10.01), and late initiation of breastfeeding (OR = 2.79, 95% CI 1.50 – 5.18) were significant factors associated with neonatal death.

Conclusion The neonatal mortality rate in NICU observed in this study was high. The majority of the deaths occurred in the early neonatal period. More than 80% of deaths recorded were due to prematurity. Preterm birth, low birth weight, low 5th minute APGAR score and late initiation of breastfeeding were significant risk factors for neonatal death. Efforts to address preterm birth, quality neonatal resuscitation and early initiation of breastfeeding are critical to achieving survival goals in newborns.

Keywords Associated factors, Mortality, Neonate, Neonatal intensive care

Background

In 2019, over 2.4 million children died in the first month of life worldwide [1]. Many neonatal deaths (75%) occur during the first week of life and about 44% die within the first 24 h of birth [2]. In 2019, Sub-Saharan Africa had

*Correspondence:
Nicholas Aguma
nicholasaguma@gmail.com
[1] Faculty of Medicine, Gulu University, Gulu, Uganda

the highest neonatal mortality rate at 27 deaths per 1,000 live births, followed by Southern Asia with 24 deaths per 1,000 live births [1].

Uganda is one of five sub-Saharan countries that account for about 50% of global neonatal mortality [3]. The other counties include Ethiopia, Nigeria, DR Congo and Tanzania. In the 5-year period before 2022, the Uganda Demographic Health Survey (UDHS) reported a neonatal mortality rate of 27 deaths per 1,000 live births.

A significant proportion of neonatal deaths occur in NICUs [4]. Neonatal mortality rates at NICU ranges from 4 to 46% in developed countries and 0.2 to 64.4% in developing countries [5]. Studies in India, Egypt, Ethiopia, and Uganda report neonatal mortality rates in NICU ranging from 10 to 30% [6–12].

Several factors such as maternal age, mode of delivery, neonatal sex, and gestational age are associated with neonatal morality [8–11, 13, 14]. A better understanding of these factors can improve neonatal outcomes, especially in low-resource settings [15].

The present study assessed the prevalence and factors associated with neonatal mortality among neonates admitted to the NICU at Lacor Hospital.

Study design

The present study collected quantitative data through retrospective descriptive review of records of 423 neonates who were admitted at the NICU from January 1st, 2023, to December 31st, 2023.

Methods

This study was conducted at the neonatal intensive care unit at St. Mary's Hospital Lacor, a private not-for-profit entity under the Uganda Catholic Medical Bureau (UCMB). The hospital is located in Northern Uganda along Gulu-Nimule Road, approximately 6 km west of Gulu city, Bardege Divison. According to hospital records, the neonatal unit admits an average of 80 newborns per month approximating to about 20 weekly admissions. Of the neonates admitted to the neonatal unit, over 75% are born at Lacor Hospital and the other 25% are either referred in from other peripheral health facilities or directly from the surrounding communities. Premature babies make up 70% of all new-born admissions. The current neonatal unit accommodates up to 15 neonates but sometimes due to overwhelming number of preterm admissions, up to 30 neonates can be accommodated with 2 or 3 babies sharing one incubator. Currently the neonatal unit operates as a level 3 facility offering semi-intensive care to prematures and sick newborns.

The special neonatal services offered include; neonatal respiratory support through non-invasive modalities using low to high flow oxygen therapy and continuous positive airway pressure (CPAP); thermoregulation for prematures; conventional phototherapy; feeding and nutrition support especially for preterms; and parenteral antibiotic therapy. The unit is managed by a team of 2 paediatricians, 04 medical officers, intern doctors, and 12 nurses/midwives working in alternate shifts.

The sample size was calculated based on the prevalence of 50% with a degree of precision of 5% and a 95% confidence interval. Allowing for 10% non-response rate in order to mitigate for selection bias that may be introduced by exclusion of participants with missing data, the estimated sample size was 423.

A systematic random sample of 423 participants were selected from the newborn inpatient register between January 1st 2023 and December 31st 2023. The total enrolled neonates (924) was divided by the sample size ($N=423$), and we obtained 2.18 as the quotient, rounded to 2 and this formed the sampling interval. Patient identification numbers of all neonates enrolled in the study were entered in an excel spreadsheet. Starting at a random position on the list, every 2nd patient was selected until the sample size (423) was reached. For each neonate selected, the mother's record was traced from the integrated maternal register (HMIS MCH 006) using the mother's name as an identifier (Fig. 1).

Study measures

Any neonate admitted to NICU who died during the neonatal period was considered as neonatal death. Sociodemographic characteristics of mothers of neonates admitted to NICU which included age of the mother at child birth in completed years and address (district); pregnancy and related delivery variables such as; gestational age at the time of delivery assessed as term (≥ 37 weeks of gestation), late preterm (gestational age from 34 weeks, 0 days to 36 weeks, 6 days.), moderate preterm (gestational age 32 weeks, 0 days to 33 weeks, 6 days) and very preterm (gestational age from 28 weeks, 0 days to 31 weeks, 6 days), mode of delivery for the current child categorized as whether the child was borne by caesarean section or vaginal delivery (as spontaneous or assisted), gravidity defined as the number of times the mother had been pregnant and assessed as primigravida or multigravida, parity defined as the number of births that the mother has had after 20 weeks of gestation and assessed as primipara, mutipara or grandmutipara, and type of pregnancy categorized as singleton or multiple birth.

Other variables included delivery related characteristics of neonates admitted to NICU such as birth weight measured at birth and categorized as normal, low or very low birth weight, neonatal gender assessed as male or

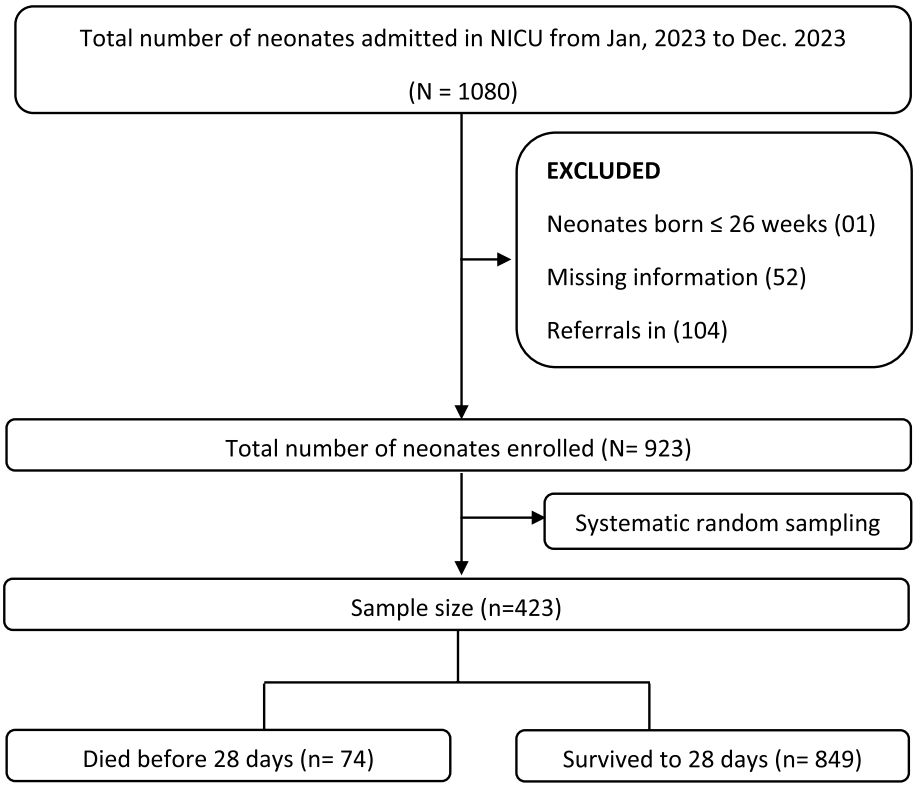

Fig. 1 Study flow diagram

female, age of the neonate at the time of death in days, appearance, pulse, grimace, activity, and respiration (APGAR) score at 5 min, neonatal morbidities such as respiratory distress syndrome (RDS) and neonatal sepsis, immediate newborn care given after birth such as initiation of breastfeeding within 1 h and whether the baby was resuscitated immediately after birth or not.

Data collection

A pretested structured data extraction tool adapted and modified from a similar study [13] was used to collect data. The dataset was checked for errors, completeness, cleaned and coded as necessary.

Data analysis

All data were entered and analysed using SPSS 27.0 statistical software (SPSS, Inc., Chicago, IL, USA. First, neonatal mortality at the NICU was described as a proportion of the total number of neonates who were admitted. Logistic regression analyses using odds ratios with 95% confidence interval (CI) were used to assess the association between possible factors associated with neonatal mortality. An adjusted odds ratio (aOR), namely an odds ratio (OR) that has been adjusted to account for other predictor variables, is provided.

The study was approved by the Gulu University Research Ethics Committee (GUREC). Registration number GUREC -2023–784.

Results

Demographic characteristics of participants

There were 423 neonates admitted to NICU of Lacor hospital who participated in the study. Of these, 204 (48.2%) were male and 294 (69.5%) mothers were aged 20–34 years (Table 1).

Neonatal mortality rate

The neonatal mortality among neonates at NICU was 74 (17.49%). Of the 74 neonatal deaths, 52 (70.27%) neonatal deaths were early neonatal deaths (0–6 days) and 22 (29.73%) were late neonatal deaths (7–28 days). Preterms deaths contributed 81.10% of overall neonatal morality recorded.

Factors associated with neonatal mortality

Bivariate analyses showed preterm neonates (< 32 weeks) were 4 times more likely to die compared to those

Table 1 Socio-demographic characteristics of mothers and neonates (*n* = 423)

Variable	Category	Frequency (%)
Address (District)	Gulu	133 (31.4)
	Omoro	59 (14.0)
	Nwoya	39 (9.2)
	Amuru	167 (39.5)
	Others	25 (5.9)
Maternal age	< 20	91 (21.5)
	20–34	294 (69.5)
	≥ 35	38 (9.0)
Gender of the Neonate	Female	204 (48.2)
	Male	219 (51.8)

born 37 weeks or more (OR = 4.06, 95% CI 2.07 – 7.98) (Table 2). Very low birth weight neonates were 4.3 times more likely to die compared to neonates with normal birth weight (OR = 4.28, 95% CI 2.14—8.56).

Neonates with APGAR score at 5 min of below 7 were 7.5 times more likely to die compared to neonates with APGAR score of 7 and above (OR = 7.50, 95% CI 3.89—14.46). Those who were not breast fed within 1 h of birth were nearly 4 times more likely to die compared to those who breastfed within 1 h of birth (OR = 3 0.71, 95% CI 2.21—6.23).

Preterm neonates born before 32 weeks were nearly 4 times more likely to die compared to term neonates (aOR = 3.81, 95% CI 1.14—12.78) (Table 3).

Neonates born to primipara mothers were 86% less likely to die at NICU compared to neonates born to grand multiparas (aOR = 0.14, 95% CI 0.02—0.84).

Neonates with APGAR score at 5 min of below 7 were 4.5 times more likely to die compared to neonates with APGAR score of 7 and above (aOR = 4.52, 95% CI 2.04—10.01). Those who were not breast fed within 1 h of birth were nearly 3 times more likely to die compared to those breastfed within 1 h of birth (OR = 2.79, 95% CI 1.50—5.18).

Discussion

In the present study, 17.49% neonatal deaths were recorded at the NICU. Nearly 70% of the deaths occurred within 7 days of birth. Preterm birth, low birth weight, low 5th minute APGAR score and late initiation of breastfeeding were associated with increased risk of neonatal death in these newborns.

The observed prevalence of neonatal death is similar to findings from a study at Mbarara regional referral

Table 2 Bivariate analyses of maternal and neonatal factors associated with neonatal mortality (*n* = 423)

Variables	Category	Admission outcome		OR (95% CI)	*P*-value
		Survived	Died		
Maternal age	< 20	77 (22.1)	14 (18.9)	0.51 (0.20, 1.28)	0.150
	20–34	244 (69.9)	50 (67.6)	0.57 (0.26, 1.26)	0.165
	≥ 35	28 (8.0)	10 (13.5)	Ref	
Gestational age	< 32	76 (21.8)	40 (54.1)	4.06 (2.07, 7.98)	*P* < 0.001
	32–33	66 (18.9)	10 (13.5)	1.17 (0.49, 2.78)	0.724
	34–36	99 (28.4)	10 (13.5)	0.78 (0.33, 1.83)	0.568
	≥ 37	108 (30.9)	14 (18.9)	Ref	
Gravidity	Primigravida	122 (35.0)	22 (29.7)	0.60 (0.29, 1.25)	0.174
	Multigravida	177 (50.7)	37(50.00	0.70 (0.35, 1.37)	0.296
	Grand multigravida	50 (14.3)	15 (20.3)	Ref	
Parity	Primipara	220 (63.0)	36 (48.7)	0.40 (0.15, 1.03)	0.056
	Multipara	112 (32.1)	31(41.9)	0.67 (0.26, 1.77)	0.420
	Grand multipara	17 (4.9)	7 (9.4)	Ref	
Type of Pregnancy	Singleton	269 (77.1)	58 (78.4)	Ref	
	Multiple	80 (22.9)	16 (21.6)	0.93 (0.51, 1.70)	0.808
Birth weight	< 1500	51 (14.6)	36 (48.7)	4.28 (2.14, 8.56)	*P* < 0.001
	1500–2500	207 (59.3)	23 (31.1)	0.67 (0.34, 1.35)	0.266
	> 2500	91 (26.1)	15 (20.3)	Ref	
APGAR score at 5 min	< 7	21 (6.0)	24 (32.4)	7.50 (3.89, 14.46)	*P* < 0.001
	≥ 7	328 (94.0)	50 (67.6)	Ref	
Initiation of Breastfeeding	Within 1 h	254 (72.8)	31 (41.9)	Ref	
	After 1 h	95 (27.2)	43 (58.1)	3.71 (2.21, 6.23)	*P* < 0.001

Table 3 Logistic regression of maternal and neonatal factors associated with neonatal mortality ($n=423$)

Variables	Category	Admission outcome		aOR (95% CI)	*P*-value
		Survived	Died		
Maternal age	< 20	77 (22.1)	14 (18.9)	1.61 (0.35, 7.48)	0.545
	20–34	244 (69.9)	50 (67.6)	1.39 (0.44, 4.41)	0.580
	≥ 35	28 (8.0)	10 (13.5)	Ref	
Gestational age	< 32	76 (21.8)	40 (54.1)	3.81 (1.14, 12.78)	0.030
	32–33	66 (18.9)	10 (13.5)	1.90 (0.53, 6.88)	0.329
	34–36	99 (28.4)	10 (13.5)	1.34 (0.40, 4.44)	0.632
	≥ 37	108 (30.9)	14 (18.9)	Ref	
Gravidity	Primigravida	122 (35.0)	22 (29.7)	2.71 (0.64, 11.39)	0.174
	Multigravida	177 (50.7)	37 (50.0)	2.17 (0.75, 6.32)	0.155
	Grand multigravida	50 (14.3)	15 (20.3)	Ref	
Parity	Primipara	220 (63.0)	36 (48.7)	0.14 (0.02, 0.84)	0.031
	Multipara	112 (32.1)	31 (41.9)	0.33 (0.07, 1.44)	0.139
	Grand multipara	17 (4.9)	7 (9.4)	Ref	
Type of Pregnancy	Singleton	269 (77.1)	58 (78.4)	Ref	
	Multiple	80 (22.9)	16 (21.6)	1.34 (0.61, 2.94)	0.463
Birth weight	< 1500	51 (14.6)	36 (48.7)	2.43 (0.70, 8.50)	0.163
	1500–2500	207 (59.3)	23 (31.1)	0.69 (0.23, 2.07)	0.507
	> 2500	91 (26.1)	15 (20.3)	Ref	
APGAR score at 5 min	< 7	21 (6.0)	24 (32.4)	4.52 (2.04, 10.01)	$P<0.001$
	≥ 7	328 (94.0)	50 (67.6)	Ref	
Initiation of Breastfeeding	Within 1 h	254 (72.8)	31 (41.9)	Ref	
	After 1 h	95 (27.2)	43 (58.1)	2.79 (1.50, 5.18)	0.001

hospital in Western Uganda [14]. This is likely because both hospitals are resource limited settings and are comparable study settings with both being referral teaching hospitals. Our finding is higher than that reported in Nigeria [16], Ethiopia [8, 17] and lower than that reported in Egypt [9]. The disparity in mortality rate is likely due to inequalities in neonatal care with specialized and well-equipped neonatal care facilities likely to provide better care unlike resource limited settings which provide suboptimal care in the inadequately equipped NICUs as observed in the present study setting. It is unsurprising that the present study reported a high neonatal mortality rate considering the study setting where the NICU facility is small and overcrowded, thus increasing risk of infections [18], and also having few modern equipments such as thermal beds, incubators, phototherapy machines not able to sustain large number of neonatal admissions at time.

Preterm delivery before 37 weeks increased the likelihood of neonatal death in NICU in this study. These findings concur with 5 previous studies in Ethiopia [6, 7, 17, 19]. Preterm are a vulnerable group more likely to be prone to complications of prematurity such as hypothermia, respiratory distress syndrome (RDS), and birth asphyxia[14]. Hypothermia is usually due to relative lack of subcutaneous fat which predisposes preterms to heat loss. Meanwhile RDS is linked to surfactant deficiency which is common with decreasing gestational age, affecting mainly neonates born before 34 weeks of gestation.

This study further found low parity as a protective factor against neonatal mortality. This finding differs from studies in Ethiopia [6, 7, 19], however it is consistent with two studies in the same country [8, 13]. This might be attributed to various factors including improved health monitoring and care for first-time pregnancies as first-time mothers are more likely to attend ANC promptly and devote more time and resources for their newborns [13]. Also, compared to low parity, high parity is associated with increased maternal age and cumulative obstetric risks which can lead to complications during pregnancy and delivery thereby increasing the risk of neonatal death [8].

In this study, the likelihood of dying in NICU for very low and low birth weight neonates were higher than neonates with normal birth weight. This concurs with findings reported in Ethiopia [6, 7, 17]. Just like their preterm counterparts, low birth weight babies are more likely to get complications such as hypothermia, infections, and birth asphyxia that can predispose to death [20].

Another finding from this study was that newborns with a low 5th minute APGAR score were more likely to

die. This finding is consistent with reports in Ethiopia [7] and Egypt [9]. This finding was expected because it is a widely held view that low 5th Minute APGAR is often associated with birth asphyxia, prematurity and intrauterine infection, all of which contribute to increased likelihood of neonatal death [21].

The risk of death was almost 3 times higher for neonates who did not start breastfeeding within one hour of birth compared to those breastfed within 1 h. This is consistent with findings from a study in Ethiopia [22]. A possible explanation for this might be that breastfeeding lowers the risk of neonatal mortality especially from hypothermia and infections such as sepsis, pneumonia, and diarrhoea through its passive immune protective effect thus babies initiated early on breast milk have high chances of survival [21]. These finding however must be interpreted with caution because initiation of breastfeeding may be influenced by more than one aspect such as early separation of sick newborn from the mother for medical attention and severe prematurity where babies cannot tolerate oral feeds due to poor suckling reflex.

Limitations of the study

This study is not free from limitations. First, there is a potential to miss neonatal deaths particularly those excluded due to incomplete information which would underestimate the overall neonatal mortality.

Secondly, since the study is a retrospective chat review based on the secondary data, inferences could not be drawn with respect to the temporal relationship among variables and association does not imply causation. Also it might be subject to information bias with the data quality dependant on the accuracy of the records.

Conclusion

The neonatal mortality rate in NICU observed in this study was high. The majority of the deaths occurred in the early neonatal period. More than 80% of deaths recorded were due to prematurity. Preterm birth, low birth weight, low 5th minute APGAR score and late initiation of breastfeeding were significant risk factors for neonatal death. Efforts to address preterm birth which contributed massively to the high mortality reported are critical to achieving survival goals in newborns. Among them includes improving the timing and quality of prenatal care for all pregnant women for early detection of risks of prematurity and instituting timely interventions.

Furthermore, encouraging early initiation of breast feeding and better neonatal resuscitation for babies with low APGAR score could contribute to the reduction of neonatal mortality in this setting.

We recommend futter studies to ascertain the contribution of poor maternal health and service-level factors such as inadequate NICU resources and inadequate staffing to neonatal death at the NICU.

Abbreviations

aOR	Adjusted odds ratio
APGAR	Appearance, Pulse, Grimace, Activity, and Respiration
AHR	Adjusted Hazard Ratio
BMI	Body Mass Index
CI	Confidence Interval
COR	Crude Odds Ratio
CHR	Crude Hazard Ratio
ENAP	Every Newborn Action Plan
NICU	Neonatal Intensive Care Unit
GUREC	Gulu University Research Ethics Committee
HMIS	Integrated Health Management Information System
MCH	Maternal and Child Health
MOH	Ministry of Health
PNFP	Private Not-For-Profit
RDS	Respiratory Distress Syndrome
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Acknowledgements

The authors thank the staff of St. Mary's Hospital Lacor for granting us permission to carry out this study. We also extend our appreciation to Gulu University, department of public health for intellectual guidance that facilitated this research.

Authors' contributions

N.A, S.E, L.E, and S.O conceived and designed the study, collected, analyzed, and interpreted the data. N.A drafted the manuscript. P.A designed the study, interpreted data, and participated in writing the manuscript. All authors read and approved for correspondence to publication.

Funding

There was no specific funding for this study.

Data availability

The dataset analyzed for the findings of this study are available with the corresponding author and can be accessed by reasonable request, and with permission of Gulu University.

Declarations

Ethics approval and consent to participate

This study was approved by Gulu University Research Ethics Committee (Uganda), approval number GUREC-2023–784. All methods were performed in accordance with the relevant guidelines and regulations. Waiver for informed consent was provided for review of records. Confidentiality and privacy was exercised throughout the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 3 October 2024 Accepted: 6 May 2025
Published online: 19 May 2025

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