Nigerian Journal of Perinatal and Neonatal Care

Original Article

A Two-Year Retrospective Hospital-Based Cross-Sectional Review of Neonatal Morbidity and Mortality: Experience from a University Teaching Hospital.

Authors: Bulus WS, Baba FJ, Bulus SG, Bakari HB, Bello M.
Department of Paediatrics, Modibbo Adama University Teaching Hospital, Yola. Adamawa State.

Author of Correspondence:

Dr Bulus Wasinda Solomon.

Department of Paediatrics, Modibbo Adama University Teaching Hospital, Yola, Adamawa State.

Email: wasindamada@gmail.com

ABSTRACT

Background:

Neonatal mortality remains a major public health challenge in Nigeria, with prematurity, birth asphyxia, infections and congenital anomalies contributing substantially to morbidity and mortality. This study examined patterns of neonatal morbidity and mortality and identified factors associated with neonatal mortality among neonates admitted to the Special Care Baby Unit (SCBU) at Modibbo Adama University Teaching Hospital (MAUTH) in Yola.

Results:

Of the 2,059 neonatal admissions during the study period, 1,960 records contained sufficient information and were included in the analysis. The leading causes of neonatal morbidity and mortality were prematurity, perinatal asphyxia, congenital anomalies, sepsis, and neonatal jaundice. Prematurity accounted for the highest proportion of deaths, while congenital anomalies had the highest case-fatality rate. In multivariable logistic regression analysis, preterm birth

Subjects and Methods:

This retrospective hospital-based study reviewed the records of neonates admitted to the SCBU at MAUTH in Yola from 1 June 2021 to 31 May 2023. Data on demographic characteristics, clinical diagnoses, place of birth, gestational age, maternal factors and outcomes were extracted from case records. Bivariate and multivariable logistic regression analyses were conducted to identify factors independently associated with neonatal mortality. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated, and statistical significance was set at $p<0.05$.

(aOR=2.27, 95% CI: 1.74-2.97, $p<0.001$), outborn status (aOR=3.28, 95% CI:2.50-4.30, $p <0.001$), primiparity (aOR=1.50, 95% CI: 1.07-2.09, p = 0.018) and grand multiparity (aOR=1.47, 95% CI: 1.06-2.03, p=0.020) were independently associated with neonatal mortality.

Conclusion:

Neonatal mortality was independently associated with prematurity, outborn status, and maternal parity. Strengthening referral systems, improving

care of the preterm infants, and enhancing maternal and newborn healthcare services may help reduce preventable neonatal deaths.

Keywords:

Newborn, Neonatal morbidity, Neonatal mortality, Prematurity, Intensive care unit.

INTRODUCTION

The neonatal period is critical for child survival, as neonatal mortality accounts for 47% of under-five mortality.[1] Worldwide, 2.3 million neonatal deaths were reported in 2023, with an average global neonatal mortality rate (NMR) of 18 deaths per 1000 live births.[4] A significant percentage (75%) of these deaths occur in the first week of life, with 25% to 45% occurring within the first 24 hours.[2,3] Where a child is born determines the likelihood of survival, which varies widely from place to place, with the majority of global neonatal deaths occurring in developing countries.[4] Sub-Saharan Africa has the highest neonatal mortality, at 27(25-32) per 1000 live births, and neonates are 10 times more likely to die within the first month of life.[5] Similarly, countries in Central and Southern Asia also have high neonatal mortality at 21 deaths per 1000 live births.[6] The lowest NMRs are reported in countries such as Andorra and Belarus, with 1 death per 1,000 live births.[9] Unlike in developed countries, where neonatal deaths are due to unavoidable deaths from congenital malformations, researchers attribute most neonatal mortality in developing countries to preventable conditions such as birth asphyxia, prematurity, and infections.[8–12] These disparities highlight significant challenges in maternal and neonatal healthcare, particularly in developing countries. Persistent challenges include limited access to skilled birth attendants, inadequate healthcare infrastructure, and underlying maternal issues [13,14] In Nigeria, neonatal mortality remained largely unchanged at 41 deaths per 1,000 live births, compared with 39 per 1,000 five years earlier.[15] This stagnation indicates limited progress in reducing newborn deaths and remains substantially above the target of 12 deaths per 1,000 live births set under Sustainable Development Goal (SDG) 3.2 of the United Nations.[16] These findings underscore the urgent need to strengthen healthcare delivery systems and improve the quality of perinatal and neonatal care in the country.

The patterns of morbidity and mortality in newborns, the magnitude of low-birth-weight babies, and neonatal outcomes are important tools for health planning and policy implementation. Periodic neonatal auditing is vital because disease rates and patterns vary across locations and over time within the same location.[17] The previous review of neonatal morbidity and mortality patterns at Modibbo Adama University Teaching Hospital (MAUTH) was over a decade ago.18 Hence, this study aims to examine the current patterns of neonatal morbidity and mortality, outcomes, and risk factors associated with neonatal mortality among newborns admitted to the Special Care Baby Unit (SCBU) of MAUTH, Yola.

SUBJECTS AND METHODS

Study site: The study was conducted at the SCBU of MAUTH, Yola. The Modibbo Adama University Teaching Hospital, Yola, Adamawa State is in north-east Nigeria. It is a tertiary institution that serves as a referral hospital for Yola, the Adamawa state capital, parts of the north-eastern states (Borno and Taraba) and the neighboring Republic of Cameroon. The SCBU is the hospital's newborn unit, where infants are admitted within the first 28 days of life. The unit has a 24-bed capacity and is equipped with 12 incubators, 5 radiant warmers, 8 LED Phototherapy machines, oxygen concentrators, and a CPAP machine. The neonatal unit is staffed by three consultant neonatologists, resident doctors, and nursing staff, with an average nurse-to-patient ratio of 1:6. The unit is organized into separate inborn and outborn sections. The inborn section manages neonates delivered within MAUTH, whereas the outborn section admits neonates delivered outside the facility and referred for specialized care. Study design: This was a retrospective hospital-based cross-sectional study. Study population: The study included all newborns admitted to the unit between 1st June 2021 and 31st May 2023 who had sufficient medical records. Babies with missing records (less than 80% of the required information) [19,20] were excluded.

Data Collection:

The names and hospital numbers of all admitted newborns were obtained from the unit's admission register, and their case folders were then retrieved from the Records and Information Department. Information extracted from the folders included age at admission, gestational age at birth (from the mother's first day of the last menstrual period for mothers who had antenatal care, or assessed using the modified Ballard maturity rating score), place of birth, mode of delivery, sex, birth weight, admitting weight, duration of hospital stay, patient's diagnosis, and outcome (discharge, discharged against medical advice, or died). Retrieved maternal information included age, parity, antenatal care, gestational type (single or multiple), educational status, and employment status.

Data analysis:

Data was collected using a structured proforma and analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized using frequencies and percentages. Neonates discharged against medical advice (DAMA) were excluded from regression analyses because their final outcomes were unknown. Missing data was handled using complete-case analysis; therefore, denominators varied across variables depending on data availability. Birth weight data were available for 1,522 neonates, maternal age for 1,893 mothers, and parity for 1,954 mothers. Logistic regression analyses were restricted to neonates with definitive outcomes (discharged alive or died), yielding an analytical sample of 1,659 neonates. Associations between neonatal mortality and selected socio-demographic and clinical characteristics were first assessed using univariable logistic regression. Variables with $p < 0.05$ in univariable analysis and those considered clinically relevant were entered into the multivariable logistic regression model to identify independent predictors of neonatal mortality. Crude odds ratios (CORs) and adjusted odds ratios (AORs) with corresponding 95% confidence intervals (CIs) were calculated, and statistical significance was set at $p < 0.05$. Multicollinearity was assessed using the Variance Inflation Factor (VIF), with values <5 indicating the absence of significant collinearity. Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test.

Ethical Clearance

Ethical clearance for the study was obtained from the MAUTH Health Research Ethics Committee with clearance no: MAUTHY/HREC/23/261.

RESULTS A total of 2,059 neonates were admitted to the SCBU during the two-year study period, of whom 1,960 (95.2%) had complete records and were included in the analysis. Males accounted for 58.3% of admissions. Most neonates were outborn (58.2%), and 65.6% presented within the first 24 hours of life. Term deliveries accounted for 71.5% of admissions, while 27.7% were preterm. Low birth weight (<2500g) was observed in 723 (47.5%) of the 1,522 neonates with documented birth weight. Vaginal delivery was the predominant mode of delivery (66.1%), and most caesarean sections were emergency procedures (644/664; 97.0%). Most neonates (59.7%) were hospitalized for ≤7 days. The demographic and clinical characteristics of the study population are summarized in Table 1.**Result :** Of the neonates admitted during the study period, 1,275 (65.0%) were discharged, 384 (19.6%) died, and 301 (15.4%) were discharged against medical advice (DAMA). Prematurity accounted for the highest number of deaths (135; 35.1%) and had a case fatality rate (CFR) of 24.9%. Perinatal asphyxia (505; 25.8%) and congenital anomalies (286; 14.6%) were also major causes of admission. Congenital anomalies had the highest CFR (27.9%), followed by prematurity (24.9%) and neonatal sepsis (24.5%). Neonatal jaundice, despite being a common diagnosis (235; 12.0%), had a relatively low CFR (9.8%) (Table 2).Male neonates constituted the majority across all outcome categories. Mortality was more common among out born neonates, who accounted for 285 (74.2%) of all deaths compared with 99 (25.8%) among inborn neonates. Many deaths occurred among neonates hospitalized for 1–7 days (217; 56.5%). Prematurity accounted for the largest proportion of neonatal deaths (135; 35.1%), followed by congenital anomalies 80 (20%) (Table3)

Table 1: Demographic and Clinical Characteristics of the Newborns Admitted into SCBU (n=1960)

Characteristic	Frequency	%
Age at presentation (days) (n=1960)		
<1	1285	65.6
1-3	301	15.4
4-7	193	9.8
8-14	112	5.7
15-21	46	2.3
fv22-28	23	1.2
Sex (n= 1960)		
Female	818	41.7
Male	1142	58.3
Place of birth (n=1960)		
Inborn	820	41.8
Outborn	1140	58.2
Outborn place of birth (n=1140)		
Secondary facility	516	45.3
Primary Health Centre	447	39.2
Home	161	14.1
Tertiary facility	16	1.4
‡Duration of gestation (n = 1960)		
Term	1402	71.5
Preterm	542	27.7
Post-term	16	0.8
Birth weight (grams) (n = 1522)		
<2500	723	47.5
2500-3999	745	48.9
≥4000	54	3.6
Admitting weight (grams) (n=1960)		
<2500	852	43.4
2500-3999	1044	53.3
≥4000	64	3.3
Mode of delivery(n=1960)		
Vaginal delivery	1296	66.1
¶Caesarean section	664	33.9
Maternal age (n=1893)		
<18 years	83	4.4
18-35	1589	83.9
>35	221	11.7
Parity (n=1954)		
1	711	36.4
2-4	869	44.5
>4	374	19.1
Multiple births (n = 1960)		
Single	1718	87.7
§Multiple	242	12.3
Length of hospital stay (in days) (n = 1960)		
1-7 days	1171	59.7
8-14 days	503	25.7
>14 286 14.6		

SCBU = Special Care Baby Unit.
† Percentages were calculated using the number of observations available for each variable as the denominator. Variations in sample size (n) reflect missing data.
‡ Duration of gestation- Preterm, term, and post-term births were defined as gestational ages of <37 weeks, 37–41 weeks, and ≥42 weeps, respectively.
§ Multiple births included twins, triplets, and higher-order multiple pregnancies.
¶ Of the 664 caesarean deliveries, 644 (97.0%) were emergency procedure.

Table 2: Pattern of morbidity, mortality, and case fatality among admitted neonates (n=1960)

Diagnosis	Frequency n (%) n=1960	Mortality n(%) n=384	CFR (%)
Prematurity	542 (27.7)	135 (35.1)	24.9
Perinatal Asphyxia	505 (25.8)	61 (15.9)	12.1
Congenital anomaly	286 (14.6)	80 (20.8)	27.9
Sepsis	261 (13.3)	64 (16.7)	24.5
Neonatal jaundice	235 (12.0)	23 (6.0)	9.8
Respiratory distress	65 (3.3)	15 (3.9)	23.1
Infant of a diabetic mother	13 (0.7)	2 (0.5)	15.4
Macrosomia	10 (0.5)	0 (0.0)	NA
Hypoglycaemia	15 (0.8)	1 (0.3)	6.6
Birth trauma	10 (0.5)	2 (0.5)	20
*Others	18 (1.0)	1 (0.3)	5.6

CFR = Case-fatality rate, calculated as the number of deaths among neonates with a specific diagnosis divided by the total number of neonates with that diagnosis, expressed as a percentage.

† Percentages in the Mortality column were calculated using the total number of neonatal deaths (n = 384) as the denominator.

‡ NA = Not applicable (no deaths were recorded for that diagnosis).

§ Others included burns, anaemia, necrotizing fasciitis, vitamin K deficiency bleeding, and hepatitis B virus exposure

Table 3: Clinical Characteristics and Outcomes of Admitted Neonates (n=1960)

Variable	Outcome		
	Discharged (n=1275)	Died (n=384)	DAMA (n=301)
Sex (n=1960)			
Female	534 (41.9)	155 (40.4)	129 (42.9)
Male	741(58.1)	229 (59.6)	172 (57.1)
Place of birth (n=1960)			
Inborn	609(47.8)	99 (25.8)	112 (37.2)
Outborn	666(52.2)	285 (74.2)	189 (62.8)
Duration of gestation (n=1960)			
Term	944 (74.0)	248 (64.6)	210 (69.8)
Preterm	319 (25.0)	135 (35.0)	88 (29.2)
Post-term	12 (0.9)	1(0.3)	3 (1.0)
Birth weight (grams) (n=1522)			
<2500	464(48.6)	153 (50)	106 (40.6)
2500-3999	456(47.7)	140 (45.8)	149 (57.1)
≥4000	35(3.7)	13 (4.2)	6 (2.3)
Admitting weight (grams) (n=1960)			
<2500	557(43.7)	177 (46.1)	118 (39.2)
2500-3999	674 (52.9)	193 (50.3)	177 (58.8)
≥4000	44 (3.5)	14 (3.6)	6 (2)
Length of hospital stay (in days) (1960)			
1-7	716 (56.2)	217 (56.5)	238 (79.1)
8-14	369 (28.9)	95 (24.7)	39 (13)
>14	190 (14.9)	72 (18.8)	24 (7.9)
Primary diagnosis (1960)			
Prematurity	319 (25.0)	135 (35.1)	88 (29.2)
Perinatal asphyxia	301 (23.6)	61 (15.9)	142 (47.2)
Congenital anomaly	175 (13.7)	80 (20.8)	31 (10.3)
Sepsis	170 (13.3)	64 (16.7)	27 (9.0)
Neonatal Jaundice	201 (15.8)	23 (6.0)	11 (3.7)
Respiratory distress	48 (3.8)	15 (3.9)	2 (0.7)
Infant of a diabetic mother	11 (0.8)	2 (0.5)	-
Macrosomia	10 (0.8)	-	-
Hypoglycaemia	14 (1.1)	1 (0.3)	-
Birth trauma	8 (0.6)	2 (0.5)	-
*Others	18 (0.9)	1 (0.3)	-

DAMA = Discharged against medical advice.
† Percentages were calculated within each outcome category (discharged, died, or DAMA).
‡ Birth weight data were available for 1,522 neonates; percentages for birth-weight categories were calculated using this denominator.
§ Differences in denominators across variables reflect missing data.

Bivariate logistic regression analysis showed that place of birth, gestational age, and parity were significantly associated with neonatal mortality. Out born neonates had significantly higher odds of death compared with inborn neonates (COR = 2.63, 95% CI: 2.04–3.39; p < 0.001). Similarly, preterm neonates had higher odds of mortality than term neonates (COR = 1.68, 95% CI: 1.32–2.15; p < 0.001). Parity was also significantly associated with neonatal mortality, with increased odds observed among primiparous and grand multiparous mothers compared with those of parity 2–4 (p = 0.042). No significant associations were observed between mortality and age at admission, sex, birth weight, admitting weight, mode of delivery, maternal age, or multiple births.

Table 4: Bivariate Logistic Regression Analysis of Factors Associated with Neonatal Mortality (n=1659)

Characteristic	Outcome		χ^2	P-value	COR	95% CI
	Alive N= 1275	**Died N= 384**				
Age at admission						
≤3 days (Ref)	1003(78.7)	308(80.2)	1.041	0.594	1.00	
4-7 days	143(11.2)	36(9.4)			1.101	0.693-1.472
8-28 days	129(10.1)	40(10.4)			0.820	0.557-1.207
Sex						
Female	533(41.8)	155(40.4)	0.263ª	0.608	0.940	0.746-1.187
Male (Ref)	741(58.12)	229(59.6)			1.00	
Duration of gestation						
Post-term	12(0.9)	1(0.3)	15.742	**<0.001***	0.321	0.042-2.484
Preterm	326(25.5)	135(35.4)			1.683	1.318-2.150
Term (Ref)	938(73.6)	247(64.3)			1.00	
Place of birth						
Inborn (Ref)	609(47.8)	99(25.8)			1.00	
Outborn	666(52.2)	285(74.2)	58.300	**<0.001***	2.632	2.043-3.393
Birth weight	**(n=955)**	**(n=306)**				
<2500g	464(48.6)	153(50)	0.564	0.754	0.931	0.716-1.211
2500-3999g (Ref)	455(47.7)	140(45.8)			1.00	
≥4000g	35(3.7)	13(4.2)			1.126	0.581-2.184
Admitting weight						
<2500g	557(43.7)	177(46.1)	0.801	0.670	0.999	0.535-1.865
2500-3999g (Ref)	674(52.9)	193(50.3)			1.00	
≥4000g	44(3.5)	14(3.6)			0.900	0.485-1.677
Length of hospital stay (in days)						
1-7 (Ref)	716(56.2)	217(56.5)	4.636	0.099	1.00	
8-14	369(28.9)	95(24.7)			0.800	0.586-1.091
≥ 14	190(14.9)	72(18.8)			0.679	0.477-0.967
Mode of delivery						
Caesarean section	419(32.9)	130(33.9)	0.131	0.717	1.046	0.821-1.331
Vaginal delivery (Ref)	856(67.1)	254(66.1)			1.00	
Parity						
1	438(35.2)	143(37.2)	6.379	**0.042***	1.475	1.078-2.018
2-4 (Ref)	507(40.7)	172(44.8)			1.00	
≥5	300(24.1)	69(18)			1.419	1.028-1.960
Maternal age	**(n=1222)**	**(n=381)**				
<18 years	49(4)	18(4.7)	2.205	0.332	1.246	0.906-1.713
18-34 years (Ref)	952(77.9)	306(80.3)			1.00	
≥35 years	221(18.1)	57(15)			1.424	0.771-2.631
Multiple births						
Singleton (Ref)	1110(87.1)	332(86.5)			1.00	
Multiple	165 (12.9)	52(13.5)	0.094	0.760	1.054	0.754-1.473

COR = Crude odds ratio; CI = Confidence interval; Ref = Reference category.

† Neonates discharged against medical advice (DAMA) were excluded because their final survival outcomes were unknown.

‡ Variables with p < 0.05 in the univariable logistic regression analysis were entered into the multivariable logistic regression model.

§ Fisher's exact test was used for sex.

¶ Birth weight data were available for 1,261 neonates (955 discharged alive and 306 died), while maternal age data were available for 1,603 mothers (1,222 discharged alive and 381 died). Differences in denominators reflect missing data.

Variables that were significantly associated with neonatal mortality on bivariate analysis were entered into a multivariable logistic regression model. After adjustment for potential confounders, gestational age, place of birth, and parity remained independently associated with neonatal mortality. Preterm neonates had more than twice the odds of death compared with term neonates (AOR = 2.27, 95% CI: 1.74–2.97; p < 0.001). Outborn neonates had over threefold higher odds of mortality compared with inborn neonates (AOR = 3.277, 95% CI: 2.501–4.295; p < 0.001). In addition, neonates born to primiparous mothers

(AOR = 1.495, 95% CI: 1.072–2.085; p = 0.018) and grand multiparous mothers (AOR = 1.467, 95% CI: 1.062–2.025; p = 0.020) had significantly higher odds of mortality compared with those born to mothers of parity 2–4 (Table 5).Assessment of multicollinearity between birth weight and gestational age revealed variance inflation factor (VIF) values <5, indicating no significant multicollinearity. The final multivariable logistic regression model demonstrated adequate fit to the data based on the Hosmer-Lemeshow goodness-of-fit test (χ^2 = 9.239, df = 6, p = 0.161).

Table 5: Multivariable regression analysis of factors associated with mortality (n=1659)

Characteristic	Outcome		AOR	95% CI	p- value
	Alive N= 1275	**Died N= 384**			
Duration of gestation					
Post-term	12(0.9)	1(0.3)	0.533	0.067-4.260	0.553
Preterm	325(25.5)	136(35.4)	2.274	1.743-2.967	**<0.001***
Term (Ref)	938(73.6)	247(64.3)	1.00		
Place of birth					
Inborn (Ref)	609(47.8)	99(25.8)	1.00		
Outborn	666(52.2)	285(74.2)	3.277	2.501-4.295	**<0.001***
Parity					
1	438(35.2)	143(37.2)	1.495	1.072-2.085	0.018
2-4 (Ref)	507(40.7)	172(44.8)	1.00		
≥5	300(24.1)	69(18.0)	1.467	1.062-2.025	**0.020***

AOR = Adjusted odds ratio; CI = Confidence interval; Ref = Reference category.
† The multivariable logistic regression model included variables that were statistically significant (p < 0.05) in the univariable analysis.
‡ Neonates discharged against medical advice (DAMA) were excluded because their final survival outcomes were unknown.
§ The final model demonstrated adequate goodness-of-fit (Hosmer–Lemeshow χ^2 = 9.239, df = 6, p = 0.161).
¶ Multicollinearity assessment showed variance inflation factor (VIF) values <5 for all variables included in the model, indicating no significant multicollinearity

DISCUSSION

The study examined patterns of neonatal morbidity and mortality, as well as the factors associated with mortality, among neonates admitted to the Special Care Baby Unit (SCBU) of a tertiary hospital in north-eastern Nigeria. Male neonates constituted most admissions consistent with reports from other neonatal units in Nigeria and elsewhere, though differing from findings in Asaba.[12,21–25]More than half of the admitted neonates were outborn, and referrals were predominantly from secondary Facilities and primary health centres. A notable proportion of the referrals originated from home deliveries suggesting a gap in perinatal and neonatal care and weaknesses in referral systems at lower levels of care. A large proportion of neonates (65.6%) presented within the first 24 hours of life. This pattern likely reflects the early onset of severe neonatal conditions and the vulnerability of newborns in the immediate postnatal period. Similarly, a high proportion of neonatal deaths occurred among infants admitted within the first three days of life, suggesting that many critically ill neonates present early in the course of illness. These findings are consistent with previous studies reporting higher mortality among early neonatal admissions.[13,27]. The overall neonatal mortality rate was 19.6%, representing a slight decrease from 20.8%, reported at the same centre over a decade ago.[20] However, it remains higher than the 10.5%, 13.2%, and 15.6% reported in Nasarawa, Kano, and Jigawa, but is comparable to the 17.6% in Lagos and the 20.4% in Zamfara.[13,14,23,27,28] This suggests a modest improvement in neonatal care but highlights persistent challenges in reducing mortality.

Discharge against medical advice (DAMA) occurred in 15.4% of neonates, higher than in many local studies.[29,30] However, this is significantly lower than the 25.4% reported in India.[31] The highest DAMA rates were observed among neonates managed for perinatal asphyxia and prematurity.

High DAMA among neonates with these conditions may reflect the severity of illness, an uncertain prognosis, and the need for prolonged, resource-intensive care. Financial constraints, limited caregiver understanding of expected outcomes, sociocultural beliefs, and reduced confidence in hospital care may further contribute to decisions to discontinue treatment.[29] Because the eventual outcomes of neonates discharged against medical advice were unknown, the true mortality burden may have been underestimated.

Globally, prematurity, birth asphyxia, neonatal infection, and congenital anomalies remain the leading causes of neonatal morbidity and mortality.[2] In this study, prematurity was the most common diagnosis, followed by perinatal asphyxia, congenital anomalies, sepsis, and neonatal jaundice. This pattern aligns with findings from previous studies in Nigeria, which reported similar morbidity patterns among admitted neonates.[9–12,21,22,30–35] The predominance of prematurity may also reflect the study centre's role as a major referral facility for very preterm infants requiring specialized care.

Prematurity accounted for the largest proportion of neonatal deaths and was an independent predictor of mortality, with preterm neonates having more than twice the odds of death compared with term neonates. This underscores the vulnerability of preterm infants to complications such as respiratory distress syndrome, sepsis, intraventricular haemorrhage, and feeding difficulties due to the immaturity of their organ systems.[36]

Congenital anomalies accounted for a substantial proportion of deaths and had the highest case-specific fatality rate (27.9%), followed by prematurity and sepsis. This finding aligns with reports identifying congenital anomalies as a major contributor to neonatal mortality in some settings.[22] However, it contrasts with several Nigerian studies where prematurity and infections predominate as causes of death.[9,11,12] The higher contribution observed in this study likely reflects the referral of complex cases from within and outside the state, many of whom were outborn and presented late due to delays in diagnosis, referral, or transportation. Most neonates with congenital anomalies in the study were outborn, which may have contributed to poorer outcomes. In resource-limited settings, limited access to antenatal diagnostic services, including routine obstetric ultrasound, leads to late detection of anomalies.

Delayed presentation and the need for urgent surgical or specialized care further worsen survival outcomes, particularly when transport challenges and comorbidities are present. Outborn status was independently associated with increased mortality, with outborn neonates having more than three times the odds of death compared with inborn neonates. This likely reflects delays in referral, inadequate stabilization before transfer, and limited capacity at peripheral facilities. These findings highlight systemic gaps in neonatal referral networks and the need to strengthen peripheral care and transport systems. The absence of significant associations between mortality and factors such as sex, birth weight, and mode of delivery suggests that mortality in this cohort is more strongly influenced by contextual vulnerabilities, particularly among outborn and preterm neonates. This underscores the need for targeted interventions to improve preterm survival. These include timely antenatal corticosteroids, continuous positive airway pressure (CPAP), surfactant therapy, appropriate parenteral nutrition, and kangaroo mother care.[2,36] Maternal parity was independently associated with neonatal mortality in this study. Neonates born to primiparous and grand multiparous mothers had higher odds of death than those born to mothers with parity of 2-4. This may reflect differences in maternal experience, pregnancy risk profiles, health-seeking behavior, and access to quality antenatal and intrapartum care. While some studies support this association, others have found no independent effect after adjusting for confounders, suggesting that socioeconomic and healthcare access factors may also play important roles.[37,38]

CONCLUSION Prematurity, perinatal asphyxia, congenital anomalies, sepsis, and neonatal jaundice were the leading causes of neonatal morbidity. Prematurity, congenital anomalies, and sepsis accounted for the largest proportions of neonatal deaths, with congenital anomalies having the highest case-fatality rate. Outborn status, preterm birth, and maternal parity were independently associated with neonatal mortality. These findings highlight the need to strengthen referral systems, improve care for preterm neonates, including respiratory and nutritional support, and enhance skilled birth attendance and access to essential neonatal care services to reduce preventable neonatal deaths.

RECOMMENDATIONS Efforts should focus on strengthening referral and transport systems, improving the quality of antenatal and perinatal care, and expanding capacity to manage preterm and critically ill neonates. Further prospective studies are recommended to explore the drivers of neonatal mortality and of discharge against medical advice in this setting.

LIMITATIONS This study was limited by its retrospective design, which relied on the completeness and accuracy of hospital records. Missing data and incomplete case retrieval may have introduced information bias. Additionally, outcomes for neonates discharged against medical advice were unknown, potentially underestimating the true mortality burden.

FUNDING The authors funded the research.

CONFLICT OF INTEREST Nil

ACKNOWLEDGENT, we acknowledge Professor Yakubu Mava, the medical records staff and the SCBU staff for their contributions.

REFERENCE

1. World Health Organization. Newborn mortality [Internet]. Geneva: WHO; 2020 [cited 2023 Jul 8]. Available from: https://www.who.int/news-room/fact-sheets/detail/neonatal-mortality.

2. World Health Organization. Newborn mortality [Internet]. Geneva: WHO; 2024. [cited 2024 Jun 9] Available from: https://www.who.int/news-room/fact-sheets/detail/neonatal-mortality

3. African Health Organization. Newborns and mortality fact sheet [Internet] [cited 2023 Jul 8]. Available from: https://www.africanhealthorganisation.org.

4. Hug Lucia, Alexander M, You D, Alkema L. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. Lancet Glob Health.

2019;7. Available from: https://www.thelancet.com.

5. United Nations Inter-agency Group for Child Mortality Estimation (UN IGME). Levels and trends in child mortality: report 2019. UNICEF; 2019. Available from: https://www.unicef.org.

6. CHAMPS Health. Neonatal mortality [Internet]. 2025. [cite Jun 9]. Available from: https://champshealth.org.

7. World Bank. Mortality rate, neonatal (per 1000 live births). World Bank Open Data. Available from: https://data.worldbank.org/indicator/SH.DYN.NMRT.

8. Thaver D, Zaidi AKM. Burden of neonatal infections in developing countries: a review. Pediatr Infect Dis J. 2009;28(Suppl 1): S3–S9. doi:10.1097/INF.0b013e3181958755

9. John KA, Olabisi FI, Olumuyiwa AA, Olawumi KA, Olubunmi BT, David BB. Pattern and causes of neonatal mortality in a tertiary hospital in Southwest Nigeria. J Kermanshah Univ Med Sci. 2020; 24(4). doi:10.5812/jkums.107385.

10. Okposio MM, Ighosewe OI. Morbidity and mortality patterns among neonates admitted to a secondary health care centre in the Niger Delta. Sri Lanka J Child Health. 2016;45(2):84–89. doi:10.4038/sljch.v45i2.7981.

11. Also U, Gwarzo G. Patterns of morbidity and mortality among neonates in a tertiary hospital. Sahel Med J. 2020;23(1):47–50. doi:10.4103/smj.smj_21_19.

12. Abdullahi U. Neonatal morbidity and mortality in a rural tertiary hospital in Nigeria. CHRISMED J Health Res. 2018;5(1):8. doi:10.4103/cjhr.cjhr_64_17.

13. Ajegbile ML. Closing the gap in maternal health access. J Glob Health Rep. 2023;7. doi:10.29392/001c.88917.

14. Ganle JK, Fitzpatrick R, Otupiri E, Parker M. Health system barriers to skilled delivery services. Int J Health Plann Manage. 2016;31(4):e235–e253.doi:10.1002/hpm.2291.

15. Nigeria Child Survival Action Plan. 2025. Available from: https://health.gov.ng.

16. World Health Organization. Global Health Observatory: SDG 3.2 neonatal mortality. Available from: https://www.who.int/data.

17. Abbasi KA. Neonatal disease profile in Larkana. J Pak Med Assoc. 1995;45:135–136.

18. Ahmadu BU, Babba HI, Abdallah JA, Tizhe AM, Ogecha A, Sunday P. Neonatal morbidity and mortality trend in Yola. Am J Health Res. 2013;1(3):99.doi:10.11648/j.ajhr.20130103.20.

19. Taye BK, Gezie LD, Atnafu A, Mengiste SA, Tilahun B. Data completeness in medical records of institutional births. BMC Health Serv Res. 2023; 23:10127. doi:10.1186/s12913-023-10127-0.

20.Weiskopf NG, Weng C. Methods and dimensions of electronic health record data quality assessment: enabling reuse for clinical research. *J Am Med Inform Assoc*. 2013;20(1):144–51. doi:10.1136/amiajnl-2011-000681. PubMed PMID: 22733976.

21.Fajolu IB, Satrom KM, Ezenwa BN, Kein AC, Slusher TM, Ezeaka VC. Current trends in neonatal morbidity and mortality: experiences from a tertiary centre in Lagos, Nigeria. *Am J Trop Med Hyg*. 2022 Jul 25;107(3):617–23. doi:10.4269/ajtmh.22-0009.

22. Audu LI, Otuneye AT, Mairami AB, Mukhtar-Yola M, Mshelia LJ. Determination of neonatal case-specific fatality rates in a tertiary health institution in North Central Nigeria. *BMC Pediatr*. 2021 Dec 1;21(1). doi:10.1186/s12887-021-02778-x. PubMed PMID: 34233637.

23. Nabwera HM, Wang D, Tongo OO, Andang'o PEA, Abdulkadir I, Ezeaka CV, et al. Burden of disease and risk factors for mortality amongst hospitalized newborns in Nigeria and

Kenya. *PLoS One*. 2021 Jan 1;16(1):e0244109.doi: 10.1371/journal.pone.0244109. PubMed PMID: 33444346.

24. Abolodje E. Neonatal mortality: morbidity pattern and risk factors in a resource-limited centre in North Central Nigeria. *Sri Lanka J Child Health*. 2021;50(3):408–15. doi:10.4038/sljch. v50i3.9688.

25.Garba B, Muhammad A, Mohammed B, Obasi A, Adeniji A. A study of neonatal mortality in a specialist hospital in Gusau, Zamfara, North-Western Nigeria. *Int J Trop Dis Health*.2017;28(2):1–6. doi:10.9734/ijtdh/2017/38337.

26.West BA, Briggs DC. Discharge against medical advice in the neonatal unit of Rivers State University Teaching Hospital, Nigeria: a two-year prospective study. *Int J Contemp Pediatr*. 2023;10(10):1483–90. doi:10.18203/2349-3291.ijcp20232874.

27. Bosco AN, Shashidhar A, Rees CA, Wheeler AD, Britto CD, Suman Rao PN. Reducing rates of discharge against medical advice in the neonatal intensive care unit in a tertiary care hospital in India: a mixed-method study. *Trop Med Int Health*. 2021;26(7):743–52.

28. Devpura B, Bhadesia P, Nimbalkar S, Desai S, Phatak A. Discharge against medical advice at the neonatal intensive care unit in Gujarat, India. *Int J Pediatr*. 2016; 2016:1897039. doi:10.1155/2016/1897039.

29. Sharma Y, Pathak OK, Sharma A, Khanal S, Baral N, Shrestha S, et al. Leave against medical advice among neonates admitted to neonatal intensive care unit in a tertiary care centre: a descriptive cross-sectional study. *J Nepal Med Assoc*. 2023;61(263):571–5. doi:10.31729/jnma.8212. PubMed PMID: 40802786.

30. Okoroiwu HU, Uchendu KI, Essien RA. Causes of morbidity and mortality among patients admitted in a tertiary hospital in southern Nigeria: a 6-year evaluation. *PLoS One*. 2020;15(8): e0237313. doi:10.1371/journal.pone.0237313. PubMed PMID: 32841255.

31.Ajaegbu OC, Igbosewe PA, Omoyibo EE, Okowa SR, Rosemary OR, Mbagwu NE, et al. Morbidity and mortality patterns of neonates admitted into a newly established special care baby unit at Asaba Specialist Hospital, Asaba, Nigeria. *Int J Contemp Pediatr*. 2025;12(2):165–9. doi:10.18203/2349-3291.ijcp20250081.

32. Onazi SO, Akeredolu FD, Yakubu M, Jiya MN, Hano IJ. Neonatal morbidity and mortality: a 5-year analysis at Federal Medical Centre, Gusau, Zamfara State, Northwest Nigeria. *Ann Med Res Pract*. 2021; 2:10. doi:10.25259/anmrp_8_2021.

33.Akpan MU, Nyong EE. Pattern of admissions into the newborn unit of University of Uyo Teaching Hospital, Nigeria. *Int J Med Res Rev* [internet], 2017 [cited Jan 2025]; 5(9): 851-6. Available from: https://ijmrr.medresearch.in/index.php/ijmrr/article/view/920.

34.Imoudu IA, Ahmad H, Yusuf MO, Makarfi HU, Umara T. An analysis of neonatal morbidity and mortality in Azare, North-Eastern Nigeria. *IOSR J Dent Med Sci*. 2014. Available from: www.iosrjournals.org.

35.World Health Organization. WHO recommendations for care of the preterm or low-birth-weight infant. Geneva: WHO; N [internet] 2022. Available from: https://www.who.int/publications/i/item/9789240058262.

36.Alkwai H, Khan F, Alshammari R, Batool A, Sogeir E, Alenazi F, et al. The association between grand multiparity and adverse neonatal outcomes: a retrospective cohort study from Ha'il, Saudi Arabia. *Children*. 2023;10(9):1541. doi:10.3390/children10091541.

37. Kozuki N, Lee AC, Silveira MF, Sania A, Vogel JP, Adair L, et al. The associations of parity and maternal age with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. *BMC Public Health*. 2013;13(Suppl 3): S2. doi:10.1186/1471-2458-13-S3-S2. PubMed PMID: 24564800.