Original

Prevalence, Complications, Outcomes and Associated Factors of Perinatal Asphyxia in a Neonatal Unit in Port Harcourt, Southern Nigeria

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Abstract

Background: Perinatal asphyxia remains a leading cause of neonatal morbidity and mortality in Nigeria. This study aimed to assess the prevalence, complications, outcomes and associated factors of perinatal asphyxia among newborns admitted to the Special Care Baby Unit of the Rivers State University Teaching Hospital (RSUTH) Nigeria.

Method: This descriptive cross-sectional study was conducted from 5th January 2021 to 4th January 2024. A structured questionnaire was used to obtain neonatal/maternal sociodemographic, clinical features, complications and outcome data. Associations between perinatal asphyxia, neonatal and maternal characteristics and ensuing complications were assessed. Logistic regression analysis was used to identify predictors of severe perinatal asphyxia.

Results: The prevalence of perinatal asphyxia was 12.5%. Of the 171 neonates with moderate/severe perinatal asphyxia, 103 (60.2%) were males, delivered at a mean gestational age of 37.09±3.43 weeks and 105 (61.4%) were admitted < 2 hours of life. The commonest pregnancy-related complications were prolonged labour 25 (19.8%) and prolonged rupture of membranes 22 (17.5%). Whereas the commonest clinical features of perinatal asphyxia were respiratory distress 135 (84.4%) and seizures 44 (27.5%), the significantly associated complications were neonatal jaundice (*P*=0.007), hypoxic ischaemic encephalopathy (*P*= <0.001) and acute kidney injury (*P*=0.036). Although 25 (14.6%) of them died, delivery at RSUTH, AOR 3.3 (CI:1.367-7.863) was the predictor significantly associated with severe perinatal asphyxia.

Conclusion: The prevalence of perinatal asphyxia was comparable to other resource-constrained settings. However, mortality remains high. Improvement of obstetric care, strengthening prompt referrals from primary healthcare and initiation of immediate neonatal resuscitation should improve asphyxia-related outcomes.

Keywords: Perinatal asphyxia, Newborn, Rivers State University Teaching Hospital, Nigeria.

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Introduction

Over the previous three decades, there has been a substantial decrease in under-five deaths globally. However, comparatively, fewer gains have been achieved regarding neonatal deaths.[1] In the year 2022, around 2.3 million infants died in their first month of life, with 6,500 fatalities occurring daily.[2] Birth asphyxia, also known as perinatal asphyxia, is the failure of the baby to establish spontaneous breathing at birth and has contributed to these ongoing neonatal deaths and is also linked to the often-debilitating long-term morbidity including motor and cognitive deficits in infants who survive.

Globally, morbidity and mortality among newborns with severe perinatal asphyxia vary significantly. However, the burden is highest in resource-constrained environments. Although Sustainable Development Goal 3 (SDG3) aims to reduce under-five deaths worldwide,[1] providing improved care for sick newborns, including skilled health personnel at birth, as well as good obstetric care, particularly in resource-constrained areas, is an essential strategy for ending preventable deaths to improve global estimates.[2] This unquestionably necessitates a deeper understanding of maternal and foetal-related factors linked to poor newborn health outcomes in such contexts.

Concerning is the fact that, to date, Nigeria remains one of the highest contributors to birth asphyxia-related deaths in the sub-Saharan African continent.[3] In 2022, the country recorded about 274,000 neonatal deaths, with asphyxia accounting for about a third of these.[1] Additionally, perinatal asphyxia is a major cause of newborn hospital admissions with prevalence rates ranging from 3% to 30%[4-6] in different parts of Nigeria with unacceptably high in-hospital deaths which have been reported to be up to 31.1%.[7]

Furthermore, previously conducted studies identified various factors associated with an increased risk of perinatal asphyxia.[4,5] These include maternal factors such as maternal age, education, parity, referral status, cadre of health staff at delivery, mode of delivery, and place of delivery. Foetal factors include sex of the baby, birth weight, and mode of delivery. In Nigeria, most public tertiary referral centres often deal with the sickest babies but still have significant opportunities to provide essential newborn care, identify and manage high-risk pregnancies if referred promptly.

This study prospectively enrolled neonates admitted to the neonatal unit of a referral centre in Southern Nigeria to determine the prevalence, complications, outcome, and determinants of perinatal asphyxia. This study posited that determining the prevalence, complications, outcomes and predictors of perinatal asphyxia would be vital for identifying potential targets for intervention and improving the care of affected neonates in our setting.

Method

Study design

This was a descriptive cross-sectional study of newborns admitted to the Special Care Baby Unit (SCBU) of the Department of Paediatrics at RSUTH between 5th January 2021 and 4th January 2024.

Study setting

Rivers State University Teaching Hospital is a 375-bed facility and one of two publicly funded tertiary hospitals providing care to children in Rivers State, Southern Nigeria. The hospital offers level IIIa neonatal care services, including respiratory and subspecialty support services for critically ill newborns (< 28 days). The SCBU consists of both inborn and outborn units and serves as a major referral unit covering state government-owned primary and secondary facilities, as well as private facilities. The staff comprises 3 consultant Paediatricians, Paediatric residents, interns, various cadres of nurses and other support staff.

Sample population

All neonates with moderate and severe perinatal asphyxia admitted into the SCBU were enrolled consecutively into the study.

Eligibility criteria

The inclusion criteria for the study were as follows:

Severe Perinatal Asphyxia (SPA): This study included all neonates who had an APGAR score of 0 to 3 at the 5th minute of life. For outborn neonates without an APGAR score, eligibility was assessed based on a history of poor or absent crying or those who required significant resuscitation measures, such as bag and mask ventilation (ambu-bagging). These infants were also required to exhibit clinical features such as seizures, loss of consciousness, central cyanosis, or floppiness.

Moderate Perinatal Asphyxia (MBA): Neonates with APGAR scores of 4 to 5 at the 5th minute of life. For outborn neonates without an APGAR score, eligibility was based on a history of poor or absent crying or requiring resuscitation methods such as stimulation or oxygen administration at birth before crying was observed.

Consent from parents or caregivers: Consent from parents or caregivers was necessary for participation in the study.

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Exclusion criteria

The study excluded neonates with moderate or severe perinatal asphyxia whose parents did not consent, as well as those with an APGAR score of 6 to 7 at five minutes (indicating mild asphyxia). Additionally, neonates with major congenital abnormalities or syndromes, and preterm infants born before 35 weeks or weighing less than 1.8 kg were also excluded.

Study size

The minimum sample size was calculated using the formula[8] $n = z^2(pq)/e^2$.

Where, n = minimum sample size; z = 1.96 at 95% confidence limits, thus $z^2 = 3.841$; p = prevalence of perinatal asphyxia; 11.1% was the prevalence of perinatal asphyxia in a study in Makurdi, Nigeria[9].

e = error margin tolerated at 5%

Minimum sample size, n = 3.8416 (0.111 x 0.889)/0.0025 = 152

Nonresponse/inappropriately data = 13% of minimum sample size = 19

Therefore, sample size = minimum sample size + attrition = 171

Data Sources/ measurement

A research assistant (house officer) was recruited before the commencement of the study and trained on the proper administration of the questionnaire as well as the inclusion/exclusion criteria. The researchers and/or research assistant obtained information on a one-on-one interview with the parents/caregivers using a pretested structured questionnaire.

Variables included neonatal/maternal sociodemographic characteristics, newborn clinical features, maternal pregnancy and birth history, maternal complications, and the complications among neonates with asphyxia and their outcomes including mortality, discharge, referred or discharge against medical advice (DAMA). Neonates with moderate to severe perinatal asphyxia were examined thoroughly and those who had severe perinatal asphyxia with hypoxic ischaemic encephalopathy (HIE) were further classified using the Sarnat staging.[10] Neonates with perinatal asphyxia were managed according to the unit's standard protocol including passive cooling and use of intravenous magnesium sulphate for severe perinatal asphyxia who met the criteria. Anticonvulsants (intravenous phenobarbitone) were used as indicated. All cases were followed up from admission to either demise or discharge.

Statistical methods

Data was analysed using SPSS version 23. Associations between the severity of perinatal asphyxia, neonatal and maternal characteristics and complications were assessed using bivariate analysis. A binary logistic regression analysis was used to identify predictors of severe perinatal asphyxia. Variables with *P* value < 0.05 in the multivariable logistic regression analysis were considered significantly associated with perinatal asphyxia. Adjusted odds ratio (AOR) with 95% confidence interval (CI) was computed.

Ethical approval

Ethical Approval was obtained from the Rivers State Ethics Review Board and consent was obtained from parents/caregivers of neonates.

Results

Of 1,372 admissions into the SCBU, 171 neonates had perinatal asphyxia giving a prevalence rate of 12.5%. Males predominated 103 (60.2%) with Male: Female ratio of 1.5:1. Most neonates were admitted within the 1st 2 hours of life 105 (61.4%), were of 1st birth order 93 (54.4%) had normal birth weights of 2500-3999g, 116 (67.8%) with a mean birth weight of 2.75 ± 0.74 kg. The majority were delivered at a gestational age of 37-42 weeks 114 (66.7%) with a mean gestational age of 37.09 3.43 weeks. APGAR scores of 0-3 and 4-5 at the 5th minute of birth were observed in 95 (55.6%) and 76 (44.4%) neonates respectively. Most mothers were aged ≥ 30 years 103 (60.2%) with a secondary level of education 86 (50.3%), Table I.

Table I: Sociodemographic characteristics of the study population

Variables	Frequency, n = 171 (%)
Sex	
Male	103 (60.2)
Female	68 (39.8)
Age at presentation (hours)	
1-2	105 (61.4)
≥ 3	66 (38.6)
Birth order	
First	93 (54.4)
Second	40 (23.4)
Third and above	38 (22.2)
Birth weight (g)	
< 2500	47 (27.5)
2500-3999	116 (67.8)

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Variables	Frequency, n = 171 (%)
≥ 4000	8 (4.7)
Gestational age (weeks)	
< 37	57 (33.3)
37-42	114 (66.7)
> 42	0
APGAR score	
4-5 (Moderate perinatal asphyxia)	76 (44.4)
0-3 (Severe perinatal asphyxia)	95 (55.6)
Mother's age (years)	
< 30	68 (39.8)
≥30	103 (60.2)
Marital status	
Married	158 (92.4)
Single	12 (7.0)
Divorced	1 (0.6)
Mother's level of education	
No formal education	12 (7.0)
Primary	18 (10.5)
Secondary	86 (50.3)
Tertiary	55 (32.2)
Mother's occupation	
Business	61 (35.7)
Artisan	46 (26.9)
Housewife	45 (26.3)
Civil servant	17 (9.9)
Professional	2 (1.2)
Father's level of education	
No formal education	10 (5.8)
Primary	18 (10.6)
Secondary	80 (46.8)
Tertiary	63 (36.8)
Residence	
Urban	106 (62.0)
Suburban	54 (31.6)
Rural	11 (6.4)
Socioeconomic class	
Lower	62 (36.3)
Middle	64 (37.4)
Upper	45 (26.3)

Most mothers were primiparous 97 (56.7%) and delivered in RSUTH 133(77.7%). Most delivered via emergency CS 79(46.2%) and had pregnancy complications 126(73.7%). The commonest pregnancy complications were prolonged labour 25(19.8%), foetal distress 22(17.5%) and PROM 22(17.5%), Table II.

Table II: Maternal pregnancy history

Variables	Frequency, n = 171 (%)
Parity	
One	97 (56.7)
Two	45 (26.3)
Three and more	29 (17.0)
Pregnancy type	
Singleton	166 (97.1)
Multiple	5 (2.9)
Place of birth	
RSUTH	133 (77.7)
PHC	38 (21.1)
General hospital	1 (1.2)
Mode of delivery	
Vaginal delivery	68 (39.8)
Elective CS	23 (13.5)
Emergency CS	79 (46.2)
Instrumental	1 (0.5)
Presence of pregnancy complications	126 (73.7)
Yes	45 (26.3)
No	
Maternal pregnancy complications	25 (19.8)
Prolonged labour	22 (17.5)
Foetal distress	22 (17.5)
Prolonged rupture of membranes	17 (13.5)
Cephalopelvic disproportion	17 (13.5)
Chronic hypertension	16 (12.7)
Eclampsia/Pre-eclampsia	11 (8.7)
Abnormal presentations	10 (7.9)
MSAF	9 (7.1)
Cord compression/prolapse	7 (5.6)
Diabetes mellitus in pregnancy	7 (5.6)
Antepartum haemorrhage	6 (4.8)
Peripartum pyrexia	1 (0.8)
Precipitate labour	

RSUTH=Rivers State University Teaching Hospital, PHC=Primary Health Care, CS= Caesarean section, MSAF= Meconium-stained amniotic fluid

The commonest clinical features of neonates with perinatal asphyxia were respiratory distress 135 (84.4%), seizures 44 (27.5%) and jaundice 40 (25.0%) while probable NNS 69 (49.6%), HIE 59 (41.7%) and hypoglycaemia 52 (37.4%) were the commonest complications. Stage III HIE 38 (52.0%) was the commonest stage while stage I, 11 (15.1%) the least, Figure Table III

Table III: Clinical features, complications of perinatal asphyxia and Sarnat's HIE staging

Variables	Frequency, n	%
Clinical features of perinatal asphyxia		
Respiratory distress	135	84.4
Seizures	44	27.5

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Variables	Frequency, n	%
Jaundice	40	25.0
Hypotonia	39	24.4
Cyanosis	36	22.5
Loss of consciousness	30	18.8
Hypertonia	28	17.5
Fever	24	15.0
Apnoea	22	13.8
Oliguria/anuria	13	8.1
Bleeding problem	12	7.5
Pallor	10	6.3
Feeding intolerance	9	5.6
Jitteriness	8	5.0
Abdominal distension	4	2.5
Complications of perinatal asphyxia		
Probable sepsis	69	49.6
Hypoxic ischaemic encephalopathy	58	41.7
Hypoglycaemia	52	37.4
Neonatal jaundice	43	30.9
Acute kidney injury	28	20.1
Anaemia	10	7.2
Disseminated intravascular coagulation	8	5.8
Birth trauma	7	5.0
Hypocalcaemia	5	3.6
Neonatal meningitis	3	2.2
Others	7	5.0
Sarnat's staging of HIE		
I	11	15.1
II	24	32.9
III	38	52.0

HIE = Hypoxic, ischaemic encephalopathy

Of 171 asphyxiated neonates admitted, 135(78.9%) were discharged home while 25 died giving a mortality of 14.6%. The mean duration of stay of discharged neonates was 11.78 ± 1.88days while the mean age at death of asphyxiated neonates was 3.97 ± 3.11days, Table IV.

Table IV: Outcome and duration of stay of neonates with perinatal asphyxia

Variables	Frequency, n = 171 (%)
Outcome of neonates	
Discharged	135 (78.9)
Died	25 (14.6)
DAMA	9 (5.3)
Referred	2 (1.2)
Duration of hospital stay (days)	
1-7	18 (14.3)
8-14	79 (62.7)
> 14	29 (23.0)

DAMA=Discharged against medical advice

Sex, age at presentation, birth weight, place of birth and mode of delivery were significantly associated with the severity of perinatal asphyxia, *P* values 0.033, 0.045, 0.011, 0.001 and 0.025 respectively, Table V.

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Table V: Association between severity of perinatal asphyxia and neonatal sociodemographic characteristics

Variables	Severity of perinatal asphyxia		Test of significance
	SPA, n=95(%)	MPA, n=76(%)	*P* value
Sex			
Male	64 (67.4)	39 (51.3)	0.033
Female	31 (32.6)	37 (48.7)	
Age at presentation (hours)			
1-2	52 (54.7)	53 (69.7)	0.045
≥ 3	43 (45.3)	23 (30.3)	
Birth order			
First	51 (53.7)	42 (55.3)	0.960
Second	23 (24.2)	17 (22.4)	
Third and above	21 (22.1)	17 (22.4)	
Birth weight			
< 2500	22 (23.2)	25 (32.9)	0.011*
2500-3999	65 (68.4)	51 (67.1)	
≥ 4000	8 (8.4)	0	
Gestational age (weeks)			
< 37	26 (27.4)	31 (40.8)	0.074
37-42	69 (72.6)	45 (59.2)	
Maternal age (years)			
< 30	44 (46.3)	24 (31.6)	0.050
≥ 30	51 (53.7)	52 (68.4)	
Parity			
One	53 (55.8)	44 (57.9)	0.940
Two	26 (27.4)	19 (25.0)	
Three and above	16 (16.8)	13 (17.1)	
Pregnancy type			
Singleton	94 (98.9)	72 (94.7)	0.173*
Multiple	1 (1.1)	4 (5.3)	
Place of birth			
RSUTH	65 (68.4)	68 (89.5)	0.001
PHC	30 (31.6)	8 (10.5)	
Mode of delivery			
Vaginal delivery	45 (47.4)	23 (30.3)	0.025*
Elective CS	8 (8.4)	15 (19.7)	
Emergency CS	41 (43.2)	38 (50.0)	
Instrumental	1 (1.1)	0	
Presence of pregnancy complications			
Yes	71 (74.7)	55 (72.4)	
No	24 (25.3)	21 (27.6)	0.727

RSUTH=Rivers State University Teaching Hospital, PHC=Primary Health Care, CS= Caesarean section, *=Fisher's exact test *P* value

Seizures, fever, respiratory distress, feeding intolerance, apnoea, hypotonia, hypertonia and unconsciousness were significantly associated with the severity of perinatal asphyxia, *P* values <0.001, < 0.001, 0.003, 0.044, 0.002, < 0.001, < 0.001 and < 0.001 respectively. Neonatal jaundice, HIE and acute kidney injury were significantly associated with the severity of perinatal asphyxia, *P* values 0.007, < 0.001 and 0.036 respectively, Table VI.

Table VI: Association between severity of perinatal asphyxia and clinical features & complications of perinatal asphyxia

Variables	Severity of perinatal asphyxia		*P* value
	SPA, n=95 (%)	MPA, n=76(%)	
Clinical features			
Seizures	41 (43.2)	3 (3.9)	< 0.001*

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Variables	Severity of perinatal asphyxia		*P* value
	SPA, n=95 (%)	MPA, n=76(%)	
Fever	21 (22.1)	3 (3.9)	< 0.001*
Respiratory distress	83 (87.4)	52 (68.4)	0.003
Cyanosis	23 (24.2)	13 (17.1)	0.257
Bleeding problems	10 (10.5)	2 (2.6)	0.068*
Feeding intolerance	8 (8.4)	1 (1.3)	0.044*
Abdominal distension	3 (3.2)	1 (1.3)	0.630*
Apnoea	19 (20.0)	3 (3.9)	0.002*
Pallor	8 (8.4)	2 (2.6)	0.188*
Hypotonia	32 (33.7)	7 (9.2)	< 0.001*
Hypertonia	27 (28.4)	1 (1.3)	< 0.001*
Jitteriness	5 (5.3)	3 (3.9)	0.734*
Unconsciousness	30 (31.6)	0 (0.0)	< 0.001*
Oliguria/anuria	9 (9.5)	4 (5.3)	0.390*
Jaundice	20 (21.1)	20 (26.3)	0.419
Complications			
Probable neonatal sepsis	36 (37.9)	33 (43.4)	0.531*
Neonatal jaundice	16 (16.8)	27 (35.5)	0.007*
HIE	56 (58.9)	2 (2.6)	< 0.001*
Acute kidney injury	21 (22.1)	7 (9.2)	0.036*
Hypoglycaemia	28 (29.5)	24 (31.6)	0.867*
Anaemia	6 (6.3)	4 (5.3)	1.000*
Hypocalcaemia	5 (5.3)	0 (0.0)	0.067*
DIC	7 (7.4)	1 (1.3)	0.077*
Birth trauma	6 (6.3)	1 (1.3)	0.134*

HIE=Hypoxix ischemic encephalopathy, DIC=Disseminated intravascular coagulopathy, *=Fisher's exact test *P* value

The odds of males having severe perinatal asphyxia was 50% significantly lower than in females while the odds of severe perinatal asphyxia among neonates admitted in the 1st 2 hours of life was almost 2x higher than those who presented later. These were not statistically significant in the adjusted odds ratio for age and sex. The odds of severe perinatal asphyxia among children delivered in RSUTH was almost 4x greater than those delivered in PHC while with the adjusted odds ratio for age and sex, its' risk was about 3x greater, Table VII.

Table VII: Predictors of perinatal asphyxia

Variables	Severity of perinatal asphyxia Reference = MPA		Severity of perinatal asphyxia Reference = MPA	
	OR (95% CI)	*P* value	AOR (95% CI)	*P* value
Sex				
Male	0.5(0.274-0.951)	0.034	0.6(0.296-1.048)	0.070
Female				
Age at presentation(hrs)				
1-2	1.9(1.010-3.594)	0.046	1.7(0.908-3.311)	0.096
≥ 3				
Mother's age (years)				
< 30	0.5(0.285-1.004)	0.052	0.6(0.317-1.159)	0.130
≥ 30				
Place of birth				
RSUTH	3.9(1.675-9.186)	0.002	3.3(1.367-7.863)	0.008
PHC				
Mode of delivery				
Vaginal delivery	1.8(0.909-3.449)	0.093	1.8(0.917-3.682)	0.086
Elective CS	0.5(0.184-1.265)	0.138	0.5(0.167-1.219)	0.117

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Variables	Severity of perinatal asphyxia Reference = MPA OR (95% CI)	*P* value	Severity of perinatal asphyxia Reference = MPA AOR (95% CI)	*P* value
Emergency CS				
Birth weight (kg)				
< 2500	1.6(0.828-3.196)	0.158	1.5(0.735-2.937)	0.276
2500-3999				

OR=Odd ratio, AOR= Adjusted odd's ratio

Discussion

The prevalence rate of perinatal asphyxia in the present study of 12.5% was consistent with the 11.1%, 11.5%, 12.3% and 13.0% reported in Makurdi[9] Nigeria, Tanzania,[11] Abuja[12] and Benin,[4] Nigeria respectively but lower than the 15.1%, 18.0%, 19.92% and 21.1% in Ethiopia[13-15] and Gusau,[7] Northwest Nigeria. Much higher prevalence rates of 28.3%, 32.8%, 35.0% and 56.9% were reported in other parts of Ethiopia,[16,17] Osogbo,[18] Nigeria and Bangladesh.[19] These varying prevalence rates could be attributable to the varying levels of obstetric care in these centres as well as variation over time. The availability and ready accessibility of antenatal care (ANC), educational levels of the mothers and cultural/religious factors could also be responsible. Also, there could be observer variations in APGAR scoring as it has been shown to have low predictive value.[20,21] In contrast, a nationwide retrospective study in the 6-geopolitical zones in Nigeria recorded a much lower prevalence rate of 3%.[5] This was not surprising as the latter study was retrospective, thus the possibility of missing data whereas the present study was prospective and a single-centre study. It is however noteworthy that in developed countries of the world, the prevalence rate is as low as 0.1%.[22]

There was male preponderance in the present study corroborating other studies in Nigeria,[6,18,23,24] Ethiopia[13-15,17] and Bangladesh.[19] This may be because of the known male predisposition to diseases due to the presence of one X chromosome unlike in females with two. The X chromosome which is the site of immunoglobulin production therefore gives females double protection.[25] In Contrast, Ilah et al[7] and Bayih et al[16] in Nigeria and Ethiopia respectively reported female predominance. The reason for this difference could not be ascertained.

The majority of neonates (61.4%) with perinatal asphyxia presented in the 1st 2 hours of life. Similar early presentations were observed in other studies.[6,7,9,14,24] This early presentation highlights the severity of the illness which is important for early intervention. In the present study, the odds of neonates who presented within the 1st 2hours of life having severe perinatal asphyxia were two times higher than those who presented later.

More than two-thirds (67.8%) of neonates had normal birth weights (2500-3999g) in the present study. This was the case with some other studies.[5-7,9,13-16] This finding was foreseeable as large babies are more likely to have foeto-pelvic disproportion resulting in prolonged obstructed labour. In contrast, Alemu et al[17] reported that low birth weight babies (LBW) were three times more likely to have perinatal asphyxia. This finding was similarly observed in Tanzania.[26] These studies were inconsistent with the present study and other studies in Nigeria.[27-29] This variation could be due to differences in geographic locations and socioeconomic status. In addition, the diagnosis of perinatal asphyxia could be exaggerated in LBW babies using the APGAR scoring system. In the present study, however, LBW babies below 1.8kg were excluded.

In the present study, severe perinatal asphyxia predominated (55.6%) as similarly reported in Gusau,[7] Nigeria where it accounted for 64.3%. This contrasts other studies where moderate perinatal asphyxia predominated accounting for 12.6%, 22.0%, 32.0%, 50.3%, 59.6%, 70.6% and 78.8% reported in Nigeria[6,7,9,18,30] and Ethiopia[15,16] respectively. The varying percentages could be because of the difference in the inclusion/exclusion criteria.

Most mothers were aged above 30 years (60.2%) in the present study. Similar age brackets were reported in other studies.[13,14,16,31] This was in agreement with the study by Abdo et al[13] who reported that older mothers aged 35 years were six times more likely to have asphyxiated babies than mothers aged 20-34 years. Much younger age groups < 30 years were however reported in other studies.[5,9,15,17] These differences could be attributed to the variations in the age grouping and geographic locations in relation to the marital age.

More than half of the neonates in the present study were of 1st birth order and their mothers primiparous. Primiparity was also reported in other parts of Nigeria[7,9] and Ethiopia.[15] This was consistent with findings by

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Abdo et al[13] which showed that asphyxia was about five times more likely in primigravida. This was similarly reported in Pakistan[19] and India.[32] This is because primiparous women may be ignorant and more likely to neglect early ANC booking, regular ANC visits, and are prone to pregnancy complications such as prolonged labour which may ultimately lead to asphyxia.[35] In other studies[5,13,14,16,17,24] multiparous women had more asphyxiated babies. The present study, however, did not show any significant association between parity and the severity of perinatal asphyxia as also documented in a study in Port Harcourt.[31]

Furthermore, about two-thirds of neonates with perinatal asphyxia were delivered via CS in the present study with most having emergency CS. This was not surprising as close to three-quarters of the mothers had pregnancy complications that may have warranted operative delivery. A similar observation was seen in Gusau,[7] Nigeria where CS accounted for 59.6% with EMCS accounting for 96.4%. This was also the observation in a previous study in Port Harcourt.[33] In contrast, vaginal deliveries predominated in other studies.[6,9,13-16,24,31] In the present study, the mode of delivery was significantly associated with the severity of perinatal asphyxia as also reported by Adebami et al[18] in Osogbo, Nigeria.

All asphyxiated neonates in the present study were delivered in hospital with more than three-quarter being in RSUTH. This was understandably so, as RSUTH is a tertiary centre and as such, difficult and complicated cases were usually referred from other peripheral centres for expert management. This could also reflect inadequate foetal monitoring during labour using a cardiotocography machine because of either unavailability or inadequate quantities. This was similarly documented in other centres.[14,24] In addition, Ilah et al[7] documented hospital delivery as a risk factor for asphyxia. It is important to note that in the present study, there was three times increased odds of severe asphyxia among neonates delivered in RSUTH after adjusting for age and sex. Contrarily, 88.3% of deliveries were carried out at home in a Bangladesh study.[19] This could therefore be responsible for the very high prevalence rate of asphyxia recorded. In addition, the level of education of the mothers could have also informed the choice of place of delivery as observed in the latter study[19] where 40.8% of mothers had no education whereas in the present study, only 7% were uneducated. In the present study, place of delivery was significantly associated with the severity of asphyxia as also reported by Adebami et al[18] and Padayachee et al[34] but inconsistent with findings by Ilah et al.[7]

The commonest maternal pregnancy/delivery complication observed in the present study was prolonged labour followed by foetal distress, PROM and CPD. Prolonged labour being the most common pregnancy/delivery complication was expected as large to normal-weight babies were mostly affected and were more likely to have foetopelvic disproportion. This was also the commonest complication in Gusau[7] and Warri,[30] Nigeria. However, pre-eclampsia/eclampsia was commonest in Makurdi,[9] Nigeria and Ethiopia.[14,16] The present study was in agreement with findings in Ethiopia[14] which showed that neonates with prolonged labour were five times more likely to develop asphyxia and a study in Enugu,[6] Nigeria showed that duration of labour > 24 hours was significantly associated with severe perinatal asphyxia. It is noteworthy that prolonged labour leads to maternal fatigue, dehydration and possible uterine rupture which could result in foetal distress predisposing the neonate to sepsis and asphyxia.[35]

Respiratory distress and seizures were the commonest clinical features seen in neonates with perinatal asphyxia. Ogunkunle et al[23] in Nasarawa state, Nigeria documented respiratory distress at presentation increased the odds for mortality. Ochoga et al,[9] Ilah et al,[7] and Reta et al[15] documented poor cry and seizures as the commonest clinical features. Variations in the severity of asphyxia could account for these differences. Probable NNS and HIE were the most common complications of perinatal asphyxia in the present study. This corroborates findings by Bayih et al[16] in Ethiopia where NNS was the commonest complication followed by birth injuries while Solayman et al[19] in Bangladesh documented HIE as the commonest complication followed by NNJ. Probable NNS being the commonest comorbidity was not surprising as prolonged labour, the commonest pregnancy complication does not only predispose the infant to asphyxia but also to sepsis.[36] In the present study, HIE stage III was the commonest (52%) followed by stage II (32.9%) and stage I (15.1%). Stage III HIE was similarly reported in an Indian study[36] as commonest (42.86%) then stage II (33.33%) and stage I (23.81%). This was because RSUTH is a referral centre hence complicated deliveries from other centres were referred for expert management. In contrast, studies in Ethiopia[14] and other parts of Nigeria[6,9,24] documented stage II as the commonest type whereas stage I accounted for > ½ of all cases in Northeast Ethiopia.[15] This difference could be due to observer variations in the rating of the stages in the various neonatal units and the level of obstetric care. In addition, the quality of neonatal resuscitation at birth could be responsible.

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Thus, training and retraining of health care professionals on neonatal resuscitation skills would improve the immediate outcome of these babies.

The mortality rate of 14.6% documented in the present study corroborated the 14.7% in Nasarawa state,[23] Nigeria. It was higher than the 5.4% and 5.5% reported in Gusau[7] and Makurdi,[9] Nigeria respectively but lower than 18.0%, 20.6% and 19.6% in other parts of Nigeria[6,24] and Ethiopia[15] respectively. Much higher mortality rates of 27.3% and 31.1% were reported in Benin[4] and Warri,[30] Nigeria respectively. The high mortality rate documented in the present study was not surprising as asphyxia is associated with high mortality rate (15-20%).[37] It is pertinent to note that the latter studies[4,30] were carried out about a decade ago. The quality of neonatal resuscitation at birth, varying technological and manpower advancement could account significantly for these differences. In the present study centre, there were no facilities for selective (head) or total body cooling although neonates with severe perinatal asphyxia who met the criteria were made to undergo endogenous cooling by consciously avoiding the use of radiant warmers and ensuring the body temperatures were not below 33.5^{o}C. Intravenous magnesium sulphate was given in severe perinatal asphyxia within 6 hours of life. These 2 therapies have been shown to reduce mortalities and improve neurologic outcomes at 18 months of age. These mortality rates are unacceptably high thus improvement of obstetric care is key to preventing asphyxia. Neonatal units in developing countries must be equipped and skilled manpower improved to reduce morbidity and mortality. In the present study, the mean duration of stay before mortality was 3.97 3.11 days, thus all hands must be on deck within the 1st week of life to avert deaths.

The present study showed that sex, age at presentation, birth weight, place of birth and mode of delivery were significantly associated with the severity of perinatal asphyxia. Gebregziabher et al[14] showed that birth weight, place of birth in addition to place of residence and gestational age were significantly associated with asphyxia. Similarly, Bayih et al[16] showed that duration of labour, mode of delivery, foetal presentation and PROM were significantly associated with asphyxia. Ekwochi et al[6] also documented sex, age at presentation and birth weight as being significantly associated with the severity of asphyxia whereas gestational age, place of delivery and mode of delivery were not. Contrary to the present study, birth weight was not significantly associated with perinatal asphyxia in Kano.[24]

The present study showed that seizures, fever, respiratory distress, feeding intolerance, apnoea, hypotonia, hypertonia and unconsciousness were significantly more in severe asphyxia than moderate asphyxia. Thus, a high index of suspicion for severe perinatal asphyxia is needed when asphyxiated babies present with these symptoms. Similarly, Adebami et al[18] showed that fever, respiratory distress, feeding intolerance, abnormal muscle tone, seizures, unconsciousness in addition to macrosomia, hypothermia, pallor, cyanosis, abdominal distension, oliguria, jitteriness, bulging fontanel were significantly more in severe asphyxia. This difference could be because of the study designs, the latter being a retrospective study. In both studies however, there was no significant association between bleeding disorders and the severity of perinatal asphyxia.

The present study showed that neonatal jaundice, HIE, and acute kidney injury were significantly associated with the severity of perinatal asphyxia. Thus, close monitoring of all asphyxiated babies is important to identify these complications early and institute prompt treatment. It is pertinent to note that perinatal asphyxia is an indication of poor and ineffective obstetric and neonatal care services thus policies must be put in place at the national level in order to curb this menace. Training and retraining of health care professionals on antenatal, intrapartum and neonatal care services should be encouraged. Education of the girl child including pregnant women on pregnancy complications will also prevent perinatal asphyxia.

Implications of the findings of this study

The prevalence of perinatal asphyxia in southern Nigeria is still high being 12.5% with high mortality rate as seen in other resource constrained settings. This study also showed that hypoxic ischemic encephalopathy, neonatal jaundice and acute kidney injury were significantly associated with the severity of perinatal asphyxia thus affected neonates must be closely monitored for early diagnosis and prompt treatment in order to avert long term sequelae.

Strengths and Limitations of the Study

The strength of this study lies in its design as a prospective observational cohort study conducted over three years. We acknowledge that classifying neonates based on clinical history for outborn admissions was subjective and may have introduced bias. Additionally, we did not conduct long-term follow-ups for all babies after discharge. Future research aimed at identifying the long-term outcomes of perinatal asphyxia would be beneficial; however, challenges related to long-term

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patient follow-up remain a significant obstacle in our setting.

Conclusion

The prevalence rate of perinatal asphyxia in RSUTH was high being 12.5%, had male preponderance with a mortality rate of 14.6%. The commonest pregnancy complications were prolonged labour, foetal distress and prolonged rupture of membranes while the commonest neonatal complications observed were probable neonatal sepsis, hypoxic ischaemic encephalopathy and hypoglycaemia. Neonatal jaundice, HIE and Acute kidney injury were significantly associated with the severity of perinatal asphyxia. Sex, age at presentation, birth weight, place of birth and mode of delivery were significantly associated with the severity of asphyxia. Perinatal asphyxia, a global phenomenon thus, has significant morbidity and mortality. Improvement of obstetric care and advancement of neonatal care as well as manpower will therefore go a long way in the drastic reduction of its prevalence, associated morbidity and high mortality rates.

Declarations

Ethical Consideration: Authors conformed to ethics in carrying out this research.

Authors' Contribution: West B.A - Designed the study, performed the statistical analysis, wrote the protocol, literature search, wrote parts of the manuscript, approved the final manuscript
Briggs D.C - Designed the study, wrote the protocol, literature search, wrote parts of the manuscript, approved the final manuscript

Conflict of interest: We hereby declare no conflict of interest

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