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ORIGINAL ARTICLE

TITLE:-HIGH BURDEN OF PERINATAL ASPHYXIA AT A TERTIARY REFERRAL HOSPITAL IN THE GAMBIA: PREVALENCE AND MODIFIABLE RISK FACTORS

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Abstract

Background: Perinatal asphyxia (PNA) is a leading cause of neonatal mortality and morbidity, disproportionately affecting low-resource settings. The Gambia lacks recent, facility-specific data on its burden and determinants, hindering targeted interventions.

Objective: To determine the prevalence of PNA and identify associated maternal and neonatal risk factors at the Edward Francis Small Teaching Hospital (EFSTH), The Gambia's primary tertiary referral center.

Methods: A retrospective cohort study was conducted. The prevalence was calculated from all live births (n = 3,936) between January 2022 and June 2023. For risk factor analysis, a case-control design was employed among inborn neonates admitted to the Neonatal Intensive Care Unit (NICU) from January to December 2022 (n = 315). Cases were neonates with PNA (5-minute Apgar score <7 and/or requiring prolonged positive-pressure ventilation). Controls were non-asphyxiated NICU admissions. Bivariate and multivariable logistic regression analyses

were performed to identify independent risk factors.

Results: The prevalence of PNA among live births was 3.15% (124/3936). PNA accounted for 33.7% (106/315) of all NICU admissions, with a case fatality rate of 30.2%. Multivariable analysis identified several independent risk factors: meconium-stained amniotic fluid (aOR=14.8, 95% CI: 8.12–26.86, p<0.001), obstructed labour (aOR=4.3, 95% CI: 2.56–7.26, p<0.001), birth weight ≥2.5kg (aOR=2.6, 95% CI: 1.59–4.36, p<0.001), term gestation (≥37 weeks) (aOR=2.3, 95% CI: 1.37–3.91, p=0.002), primiparity (aOR=1.8, 95% CI: 1.10–2.88, p=0.02), and lack of maternal formal education (aOR=1.8, 95% CI: 1.07–3.03, p=0.03).

Conclusion: Perinatal asphyxia represents a significant burden at EFSTH, driven by intrapartum complications and deep-rooted social factors. A multi-faceted intervention strategy is urgently needed, encompassing improved intrapartum monitoring and emergency obstetric care, enhanced neonatal resuscitation, and long-term investments in female education.

Running Title

PERINATAL ASPHYXIA IN THE GAMBIA

Keywords: Perinatal Asphyxia; Neonatal Mortality; Risk Factors; The Gambia; Low- and Middle-Income Countries (LMICs); Obstructed Labour

Introduction

Perinatal asphyxia (PNA), characterized by the failure to initiate or sustain spontaneous breathing at birth, remains a devastating catalyst for neonatal mortality and long-term neurodevelopmental impairment worldwide.[1] It is a primary contributor to the burden of intrapartum-related adverse events, accounting for an estimated 900,000 deaths out of the 4 million neonatal deaths annually, most of which are concentrated in low- and middle-income countries (LMICs).[2-4] For every newborn that dies, many more survive with severe multi-organ dysfunction, lifelong disabilities such as cerebral palsy, epilepsy, and cognitive deficits, creating an immense socio-economic burden for families and healthcare systems.[5,6]

The Apgar score, assessed at 1 and 5 minutes of life, remains a cornerstone for the initial diagnosis and severity stratification of PNA, particularly in resource-constrained settings where advanced diagnostics are limited. A score of less than 7 at the 5th minute is widely used to define the condition, and its severity is graded from mild to profound.[1,2,7,8] The incidence of PNA exhibits stark global inequity. While high-income countries report rates as low as 0.2-0.3 % among live births, the prevalence in sub-Saharan Africa is alarmingly higher, with recent meta-analyses estimating a pooled prevalence of 17.28% among hospital-based studies, with case fatality rates often exceeding 30%.[9-11] This disparity underscores the critical influence of socioeconomic determinants and the quality of obstetric and neonatal care.

Identified risk factors for PNA are multifactorial, spanning maternal, intrapartum, and fetal domains. Key contributors include primiparity, low

maternal education, limited antenatal care utilization, obstetric emergencies like obstructed labor and pre-eclampsia, and intrapartum events such as meconium-stained amniotic fluid and fetal distress.[11-13] Addressing these factors requires robust health systems capable of providing timely and high-quality care during pregnancy, delivery, and the critical golden minute after birth.

Despite the high regional burden, there is a profound paucity of recent, context-specific data on the prevalence and determinants of PNA in The Gambia. As the country strives towards achieving the Sustainable Development Goal (SDG) target of reducing neonatal mortality to ≤12 per 1000 live births by 2030, understanding and addressing the major causes of newborn death is imperative.[4] This study, therefore, aimed to determine the prevalence of perinatal asphyxia and identify its associated maternal and neonatal risk factors at the Edward Francis Small Teaching Hospital (EFSTH), The Gambia's sole tertiary referral and teaching hospital. The findings are crucial for informing targeted interventions, guiding policy, and optimizing resource allocation to curb the unacceptably high burden of preventable newborn morbidity and mortality in The Gambia.

Methodology

Study Design and Setting

This was a retrospective, hospital-based cohort study at the Neonatal Intensive Care Unit of the EFSTH in Banjul. The NICU is a 58-bed facility that provides care for both inborn and outborn neonates, staffed by a consultant neonatologist, resident doctors, and a minimum of four nurses per shift.

Study Population and Eligibility Criteria

The study comprised two distinct populations to address its dual objectives:

1. **Prevalence Cohort:** All live births delivered at the EFSTH labour ward and theatre between 1st January 2022 and 30th June 2023 (n=3936). The 18-month period was chosen to ensure a sufficiently large sample size for a robust prevalence estimate.
2. **Risk Factor Cohort:** All inborn neonates (delivered at EFSTH) admitted to the NICU between 1st January 2022 and 31st December 2022 (n=315). This 12-month period provided a focused cohort for a detailed case-control analysis within the admissions.

Inclusion Criteria:

- For the prevalence cohort: All live births at EFSTH during the study period.
- For the risk factor cohort: All inborn neonates admitted to the NICU during the specified period.

ExclusionCriteria:

Neonates with any of the following were excluded from the risk factor analysis to minimize confounding:

- Major congenital anomalies or syndromes (e.g., congenital heart disease, chromosomal abnormalities).
- Preterm birth at <35 completed weeks of gestation. This is because preterm neonates often have low Apgar scores due to physiological immaturity rather than intrapartum asphyxia.

Operational Definitions

- **Perinatal Asphyxia (Case Definition):** Was defined as a fifth-minute Apgar score of <7 **and/or** the requirement of positive pressure ventilation (PPV) for more than one minute immediately after birth.[1,2,7,8]
- **Non-Asphyxiated Controls:** Neonates admitted to the NICU for other reasons (e.g., prematurity ≥35 weeks, infections or jaundice) with a 5-minute Apgar score ≥7.
- **Obstructed Labour:** Arrest of progress in labour despite adequate uterine contractions.
- **Meconium-Stained Amniotic Fluid (MSAF):** The presence of meconium in the amniotic fluid, irrespective of consistency.

Data Collection and Variables

A structured data extraction tool was pre-designed and used to collect information from maternal and neonatal medical records. The extracted data included:

1. **Maternal Sociodemographic Factors:** Age, marital status, residency (urban/rural), and educational attainment.
2. **Antepartum Factors:** Parity, antenatal care (ANC) attendance, and medical/obstetric disorders (e.g., preeclampsia/eclampsia, gestational diabetes, antepartum haemorrhage, anaemia).
3. **Intrapartum Factors:** Type of labour (spontaneous/induced), duration of labour, mode of delivery (vaginal/cesarean), presence of obstructed labour, prolonged rupture of membranes (PROM >18 hours), meconium-stained liquor, and fetal presentation.
4. **Neonatal Factors:** Sex, birth weight, gestational age, Apgar scores at 1 and 5 minutes, and immediate outcome (discharged, died, discharged against medical advice).

Data Management and Statistical Analysis

Data were anonymised at the point of extraction to ensure confidentiality. They were entered, cleaned, and coded using Microsoft Excel® and subsequently analysed using IBM SPSS Statistics for Windows, Version 28.0.

Descriptive statistics were computed for all variables. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized as means (± standard deviation) or medians (interquartile range) based on their distribution.

To identify factors associated with perinatal asphyxia, bivariate analyses were performed using the Chi-square test (or Fisher's exact test where appropriate) for categorical variables. Variables with a p-value < 0.05 in the bivariate analysis were included in a multivariable binary logistic regression model to determine adjusted odds ratios (aOR) and their 95% confidence intervals (CIs), controlling for potential confounders. The model's goodness of fit was assessed using the Hosmer-Lemeshow test. A two-tailed p-value of < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for this study was granted by the EFSTH Research and Ethics Committee with approval number: EFSTH_REC_2023_063. The approval was in accordance with the Declaration of Helsinki on research in human subjects. Confidentiality was maintained throughout the research process; all data were anonymized and stored on a secure, password-protected computer.

Results

Prevalence of Perinatal Asphyxia

There were 3,936 live births at the EFSTH during the study period. Among these, 124 neonates were diagnosed with perinatal asphyxia (PNA), yielding an incidence of 31.5 per 1000 live births.

A separate analysis of Neonatal Intensive Care Unit (NICU) admissions between January 1 and December 31, 2022, provided further insight into the disease burden. Of the 315 inborn neonates admitted to the NICU during this period, 106 were admitted due to PNA, yielding a prevalence of 33.7% for PNA in the NICU.

Baseline Characteristics of the Study Population

The baseline characteristics of the 315 NICU-admitted inborn neonates and those of their mothers are summarized in Table 1.

The median maternal age range was 26-30 years. The majority of mothers were married (93.3%, n = 294) and had attended at least one antenatal care visit (93.3%, n = 294). Two hundred and thirty-five mothers (74.6%) had no formal education. Caesarean section was the mode of delivery for 54.6% (n=172) of the births.

There was a male preponderance (54.0%, n = 170). Most infants were term (58.7%, n=185) and of normal birth weight between 2500-3999g (45.7%, n=144). Based on the 5-minute Apgar score, 66.4% (n=209) had a normal score (7-10), 31.8% (n=100) had mild-moderate asphyxia (score 4-<7), and 1.9% (n=6) had severe asphyxia (score 1-3).

Table 1: Baseline Characteristics of Neonates Admitted to the Neonatal Intensive Care Unit and their mothers

Parameter (N=315)	Frequency (%)
Maternal Characteristics	
Median age class (years)	26-30
Parity	
Primipara	117 (37.1)
Multipara	124 (39.4)
Grand multipara	74 (23.5)
Attended ≥1 ANC visit	294 (93.3)
Level of Education	
No Formal Education	235 (74.6)
Primary	21 (6.7)
Secondary	42 (13.3)
Tertiary	17 (5.4)
Mode of Delivery	
Vaginal Delivery	143 (45.4)
Caesarean Section	172 (54.6)
Neonatal Characteristics	
Sex	
Male	170 (54.0)
Female	145 (46.0)
Gestational Age	
Preterm (35 <37 weeks)	112 (35.6)
Term (37-41 weeks)	185 (58.7)
Post-term (≥42 weeks)	18 (5.7)
Birth weight (grams)	
<2500 (Low Birth Weight)	133 (42.2)
2500-3999 (Normal)	144 (45.7)
≥4000 (Macrosomic)	34 (10.8)
Not Available	4 (1.3)
APGAR Score at 5 minutes	
8-10 (Normal)	209 (66.4)
4-7 (Mild-Moderate Asphyxia)	100 (31.8)
1-3 (Severe Asphyxia)	6 (1.9)

Maternal and Intrapartum Complications

Pregnancy and intrapartum complications were highly prevalent. Among the mothers who delivered babies subsequently admitted to the NICU, 23.2% (n=73) had hypertensive disorders, and 7.0% (n=22) had diabetes or gestational diabetes.

The analysis of the 106 asphyxiated neonates revealed even more pronounced complications. Over 64% (n=68) of their mothers experienced a pregnancy disorder, with hypertensive disorders (42.7%) being the most common. During labour, 62.3% (n=66) of mothers of asphyxiated neonates had meconium-stained amniotic fluid, and 48.1% (n=51) experienced obstructed labour.

Neonatal Outcomes

The case fatality rate among the 106 asphyxiated neonates admitted to the NICU, was 30.2% (32/106). Sixty-nine (65.1%) were successfully discharged home, and 5 (4.7%) were discharged against medical advice (DAMA).

Factors Associated with Perinatal Asphyxia

The binary logistic regression analysis identified several factors significantly associated with an increased odds of perinatal asphyxia (Table 2).

Maternal and Obstetric Factors:

- Obstructed labour was the strongest obstetric predictor, associated with a four-fold increased odds of PNA (OR = 4.3, 95% CI [2.56 - 7.26], p < 0.001).
- Maternal lack of formal education significantly increased the odds of PNA by 80% (OR = 1.8, 95% CI [1.07 - 3.03], p = 0.03).
- Primiparity was associated with an 80% increased odds of delivering an asphyxiated baby (OR = 1.8, 95% CI [1.10 - 2.88], p = 0.02).

Neonatal Factors:

- The presence of meconium-stained amniotic fluid (MSAF) was the most potent predictor overall, associated with a nearly 15-fold increase in the odds of PNA (OR = 14.8, 95% CI [8.12 - 26.86], p < 0.001).
- Term infants (≥37 weeks) had more than twice the odds of experiencing asphyxia compared to preterm infants (OR = 2.3, 95% CI [1.37 - 3.91], p = 0.002).
- Neonates with a birth weight ≥2.5kg had 2.6 times higher odds of PNA compared to low birth weight infants (<2.5kg) (OR = 2.6, 95% CI [1.59 - 4.36], p = 0.0002).
- Hypertensive disorders in pregnancy, maternal residence (rural vs. urban), and mode of delivery (cesarean vs. vaginal) were not found to be significantly associated with PNA in this cohort.

Table 2: Factors Associated with Perinatal Asphyxia (N=315)

Variable	Category	(aOR)	95% CI	p-value
Educational Level	No formal education vs. Educated	1.8	1.07 - 3.03	0.03
Parity	Primipara vs. Multipara/Grand Multipara	1.8	1.10 - 2.88	0.02
Obstructed labour	Yes vs. No	4.3	2.56 - 7.26	<0.001
Meconium-stained liquor	Yes vs. No	14.8	8.12 - 26.86	<0.001
Gestational Age	≥37 Weeks vs. <37 weeks	2.3	1.37 - 3.91	0.002
Birth weight	≥2.5Kg vs. <2.5Kg	2.6	1.59 - 4.36	<0.001
Hypertensive disorders	Yes vs. No	1.4	0.82 - 2.43	0.21
Residence	Rural vs. Urban	1.08	0.64 - 1.85	0.77
Mode of delivery	Vaginal vs. Cesarean Section	1.3	0.79 - 2.05	0.32

Discussion

This study provides the first comprehensive analysis of the burden and determinants of perinatal asphyxia (PNA) at The Gambia's sole tertiary referral hospital. The findings paint a concerning picture: the incidence of 31.5 per 1000 live births, accounting for a third of all NICU admissions, and a devastating case fatality rate of 30.2%. These figures are not merely statistics but reflect a significant public health challenge

contributing to neonatal mortality in The Gambia. Our analysis identifies obstructed labour, meconium-stained amniotic fluid, and low maternal education as the paramount risk factors, highlighting critical areas for intervention.

The prevalence of PNA in our NICU (33.7%) was lower than the 41.2% reported in a specialized hospital in Ethiopia [11],but was significantly higher than the 13.0% found in a rural Nigerian hospital setting.[14] This discrepancy is likely due to the patient population. The Gambia is a much smaller country compared to Ethiopia, but as the national referral center, EFSTH manages the most complex obstetric cases, inevitably leading to a higher concentration of high-risk deliveries and adverse outcomes, such as PNA, compared to smaller, rural primary facilities.[14,15] The proportion of NICU admissions due to PNA (33.7%) also aligns closely with another study from a referral hospital in East Africa, which reported rates of 32.8%,[16] underscoring that PNA is a leading cause of critical neonatal illness across the region.

The observed male preponderance (58%) among asphyxiated neonates is consistent with findings from Ethiopia and Cameroon. [17,18] This recurring "male disadvantage" may be attributed to the larger head circumference and birth weight of male infants,[19] potentially increasing their susceptibility to mechanical challenges during childbirth, such as obstructed labour. [20] This hypothesis is supported by our own findings, where higher birth weight (≥2.5kg) and term gestation were significant risk factors, doubling the odds of PNA. Although our study did not assess head circumference, maternal height, and nutritional status, these factors could have contributed to the observed outcome.

A particularly alarming finding is the strong association between meconium-stained amniotic fluid (MSAF) and PNA, with an adjusted odds ratio of 14.8. This is substantially higher than the 3.5 to 6.5 odds ratios reported in similar studies.[12,13] MSAF is a well-known sign of fetal distress.[1] The dramatically elevated risk in our cohort likely reflects not just the presence of meconium but the severity and chronicity of the intrapartum hypoxia event. Many patients referred to EFSTH experience prolonged labour and delayed access to definitive care, allowing meconium aspiration to occur and exacerbate the initial hypoxic insult. This underscores a critical failure in the timely detection and management of fetal distress within the referral pathway.

Similarly, obstructed labour was a major independent predictor of PNA (aOR=4.3), a finding consistent with a recent Ethiopian meta-analysis that highlighted its devastating impact on fetal outcomes.[21] Obstructed labour is a quintessential indicator of delays in seeking care (Delay 1), reaching a facility (Delay 2), and receiving adequate obstetric intervention (Delay 3). Its high prevalence points to systemic issues, including a shortage of facilities capable of performing emergency cesarean sections and logistical barriers to transportation, concentrating these worst-case scenarios at the tertiary level.

Perhaps the most socially resonant finding is the strong association between a lack of maternal formal education and PNA (aOR=1.8). This finding aligns with studies from Kenya and Pakistan,[22,23] but was more

pronounced in our setting, where 74.6% of mothers had no formal schooling. Maternal education is a key social determinant of health, influencing health-seeking behaviors, comprehension of health messages, autonomy in decision-making, and economic empowerment.[15,24] Uneducated mothers may be less likely to recognize danger signs in pregnancy, adhere to antenatal care, or advocate for themselves during labour, leading to delays that culminate in adverse birth outcomes. This finding argues for interventions that extend far beyond the clinic walls into girls' education and women's empowerment.

Contrary to some studies [25,26], hypertensive disorders and mode of delivery were not significant risk factors in our final model. This may be due to the overwhelming effect of the primary predictors (obstructed labour, MSAF) or the success of the hospital's protocol-driven management of conditions like pre-eclampsia, which may mitigate their final impact on the newborn when managed correctly.

The high mortality rate (30.2%) is a sobering reminder of the consequences of the identified gaps. It calls for a dual strategy: primary prevention through community education and improved obstetric care to reduce the incidence of PNA, and secondary prevention through enhanced neonatal resuscitation to improve outcomes for affected newborns. Scaling up programs like Helping Babies Breathe (HBB) [27] and ensuring the availability of continuous positive airway pressure (CPAP) in referral centers are essential next steps.

Limitations: The Validity of the results of this retrospective study relies on the accuracy and completeness of medical records. The high fatality rate was incongruous with the proportion of severe birth asphyxia (1.9%) reported in this study. The retrospective nature could not allow for assessing the efficiency of the scoring system employed to diagnose the PNA.
The use of Apgar scores for diagnosis, although practical, has been shown to have inherent subjectivity. Furthermore, as a single-center study at a tertiary facility, the findings may not be generalizable to the entire Gambian population, as they represent the most severe end of the disease spectrum. Future prospective, multi-center studies are recommended.

Conclusion and Recommendations
Perinatal asphyxia remains a formidable cause of neonatal mortality and morbidity at The Gambia's main referral hospital, driven by intrapartum emergencies and deep-rooted social determinants. To combat this, we recommend:

1. **Health System Strengthening:** Decentralizing emergency obstetric care capabilities to reduce delays and the burden of obstructed labour.
2. **Community Intervention:** Implementing targeted community education programs to improve the recognition of danger signs and encourage timely facility-based delivery.
3. **Clinical Training:**

Nationwide scaling up of HBB and other neonatal resuscitation training for all birth attendants.

4. **Policy Action:** bolstering policies focused on female education, given its profound downstream effects on maternal and child health. Addressing PNA requires a concerted effort that bridges clinical practice, public health initiatives, and socio-economic policy.

List of abbreviations:

ANC – Antenatal Care

CPAP – Continuous Positive Airway Pressure

DAMA – Discharge Against Medical Advice

EFSTH – Edward Francis Small Teaching Hospital

HIE – Hypoxic Ischaemic Encephalopathy

LMIC – Low- and Middle-Income Countries

MSAF – Meconium-stained amniotic fluid

NICU – Neonatal Intensive Care Unit

PNA – Perinatal Asphyxia

PPV – Positive Pressure Ventilation

PROM – Prolonged rupture of membrane

SDG - Sustainable Development Goals

Declarations

- **Ethics approval and consent to participate:** Ethical approval for this study was granted by the EFSTH Research and Ethics Committee. As a retrospective review of records, the requirement for individual informed consent was waived by the ethics committees. However, strict confidentiality was maintained throughout the research process
- **Consent for publication:** All authors have approved the manuscript and agree with its submission to *BMC Global and Public Health*.
- **Availability of data and materials:** All data supporting the findings of this study are available within the article.

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Authors' contributions: FB contributed to the study development, including concept and design, participated in the acquisition of data, and drafted and revised the manuscript for intellectual content. BE contributed to the study development, including concept and design, supervised the acquisition of data and analysis, participated in the drafting of the manuscript, and revised the manuscript for intellectual content. PI contributed to the study development and design, supervised the acquisition of data, and revised the manuscript for intellectual content. All the authors approved the final version submitted for publication.

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