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NEONATAL BIRTH ASPHYXIA. A COMPREHENSIVE ANALYSIS OF MATERNAL, OBSTETRIC AND FETAL RISK FACTORS IN TERM NEONATES

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Abstract

Background: *Birth asphyxia remains a leading cause of neonatal morbidity and mortality, particularly in low- and middle-income countries. Identifying maternal, obstetric, and fetal risk factors is crucial for developing targeted interventions to reduce its incidence.*

Objective: *This study aimed to assess the prevalence of birth asphyxia and its associated risk factors among term neonates at a tertiary care hospital.*

Methods: *A retrospective cohort study was conducted at the Pediatrics and Gynecology & Obstetrics Departments of Khyber Teaching Hospital and Hayatabad Medical Complex, Peshawar, from January 2022 till December 2024. Data from 2,500 term neonates were analyzed, including maternal, obstetric, and fetal variables. Birth asphyxia was defined as an Apgar score <7 at 5 minutes, need for positive pressure ventilation, or evidence of hypoxic-ischemic encephalopathy (HIE). Univariate and multivariate logistic regression analyses were performed to identify independent risk factors.*

Results: *The prevalence of birth asphyxia was 10% (n=250). Maternal hypertension (aOR=2.2, 95% CI: 1.6–3.0), inadequate antenatal care (aOR=2.5, 95% CI: 1.8–3.5), prolonged labor (aOR=2.4, 95% CI: 1.7–3.4), and meconium-stained amniotic fluid (aOR=3.0, 95% CI: 2.2–4.1) were significant independent risk factors. Cesarean section (aOR=2.0, 95% CI: 1.5–2.8) and low birth weight (aOR=2.3, 95% CI: 1.6–3.3) were also associated with increased risk.*

Conclusion: *Maternal hypertension, inadequate antenatal care, prolonged labor, and meconium-stained amniotic fluid are key risk factors for birth asphyxia in term neonates. Strengthening antenatal care, improving intrapartum monitoring, and timely intervention are essential to reduce the burden of birth asphyxia and its associated complications.*

INTRODUCTION

Birth asphyxia remains a major global health concern, contributing significantly to neonatal morbidity and mortality (1). It is defined as the failure to establish and sustain spontaneous breathing at birth, leading to hypoxic-ischemic injury and potential long-term neurological complications such as cerebral palsy, developmental delay, and epilepsy (2). The prevalence of birth asphyxia varies worldwide, with higher rates reported in resource-limited settings due to disparities in maternal healthcare access and quality of obstetric care (3). Despite advancements in perinatal care, birth asphyxia continues to be a significant cause of neonatal deaths, accounting for nearly 23% of all neonatal mortality globally (4).

Several maternal, obstetric, and fetal risk factors contribute to birth asphyxia. Maternal factors such as advanced maternal age, hypertension, diabetes, and infections during pregnancy have been strongly associated with an increased risk of perinatal asphyxia (5). Additionally, inadequate antenatal care, maternal malnutrition, and anemia can compromise placental function, reducing oxygen supply to the fetus (6). Obstetric complications, including prolonged labor, premature rupture of membranes, uterine rupture, and placental abruption, are well-documented risk factors for birth asphyxia, as they disrupt the oxygenation process during labor and delivery (7).

Fetal factors also play a crucial role in the pathophysiology of birth asphyxia. Intrauterine growth restriction (IUGR), macrosomia, fetal distress, meconium-stained amniotic fluid, and abnormal fetal heart rate patterns are significant predictors of birth asphyxia (8). Furthermore, umbilical cord complications such as cord prolapse, true knots, and nuchal cords can impede fetal oxygenation, leading to perinatal hypoxia (9).

Understanding the interplay between maternal, obstetric, and fetal risk factors is crucial for developing effective preventive strategies and improving neonatal outcomes. Early identification of high-risk pregnancies, timely medical interventions, and improved access to quality obstetric care can significantly reduce the incidence of birth asphyxia (10). This study aims to comprehensively analyze the influence of maternal, obstetric, and fetal risk factors on birth asphyxia in term neonates, highlighting key areas for clinical and policy interventions.

MATERIALS AND METHODS

This retrospective cohort study was conducted at the Pediatrics Department and Gynecology & Obstetrics Department of Khyber Teaching Hospital and Hayatabad Medical Complex, Peshawar, Pakistan from January 2022 till December 2024. The study population includes all term neonates (≥37 weeks of gestation) delivered at Khyber Teaching Hospital and Hayatabad Medical Complex,Peshawar during the study period. Neonates with congenital anomalies, those born preterm (<37 weeks), or those with incomplete medical records were excluded from the analysis. The sample size was determined based on statistical calculations to ensure adequate power for detecting significant associations. A minimum sample size of 250 neonates was estimated using the formula for cross-sectional studies, assuming a 10% prevalence of birth asphyxia, a 95% confidence level, and a 5% margin of error. Data were extracted from hospital records, including maternal, obstetric, and neonatal medical files. A structured data collection form was developed to systematically record information on the following variables:

1. Maternal Factors:

- Age, parity, and socioeconomic status.
- Medical conditions (e.g., hypertension, diabetes, anemia, infections).
- Antenatal care attendance and nutritional status.

2. Obstetric Factors:

- Mode of delivery (spontaneous vaginal delivery, assisted vaginal delivery, or cesarean section).
- Duration of labor (prolonged or obstructed labor).
- Use of labor-inducing agents (e.g., oxytocin).
- Presence of complications (e.g., antepartum hemorrhage, placental abruption).

3. Fetal Factors:

- Birth weight (normal, low birth weight, or macrosomia).
- Presence of meconium-stained amniotic fluid.
- Apgar scores at 1 and 5 minutes.

Outcome Variable

Diagnosis of birth asphyxia, defined as an Apgar score of <7 at 5 minutes, need for positive pressure ventilation, or evidence of hypoxic-ischemic encephalopathy (HIE) (2).

Data were entered into a secure electronic database and analyzed using statistical software (e.g., SPSS version 25 or R). Descriptive statistics were used to summarize the characteristics of the study population. Continuous variables were expressed as means ± standard deviations (SD), while categorical variables were reported as frequencies and percentages. Univariate and multivariate logistic regression analyses were performed to identify independent risk factors associated with birth asphyxia. Adjusted odds ratios (aOR) with 95% confidence intervals (CI) were calculated to quantify the strength of associations. A p-value of <0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Khyber Teaching Hospital. Confidentiality of patient data was maintained throughout the study, and all data were anonymized to protect patient privacy. Informed consent was waived due to the retrospective nature of the study.

RESULTS

A total of 2,500 term neonates were included in the study, of which 250 (10%) were diagnosed with birth asphyxia. The mean maternal age was 28.5 ± 5.2 years, and 1,625 (65%) of the mothers were multiparous. Among the maternal risk factors, hypertension was present in 375 (15%), diabetes in 200 (8%), and anemia in 300 (12%) of the mothers. Additionally, 500 (20%) of the mothers had inadequate antenatal care attendance, and 250 (10%) had a history of maternal infections such as chorioamnionitis.

Regarding obstetric factors, 1,750 (70%) of the deliveries were spontaneous vaginal deliveries, while 500 (20%) were cesarean sections, and 250 (10%) were assisted vaginal deliveries. Prolonged labor was observed in 375 (15%) of cases, and 200 (8%) of deliveries involved the use of labor-inducing agents. Complications such as antepartum hemorrhage were present in 125 (5%) and placental abruption in 75 (3%) of cases.

Among fetal factors, 300 (12%) of neonates had meconium-stained amniotic fluid, and 200 (8%) were classified as low birth weight (<2.5 kg). The mean Apgar score at 1 minute was 6.2 ± 1.5, and at 5 minutes, it was 8.1 ± 1.2. Neonates with birth asphyxia had significantly lower Apgar scores at both 1 minute (4.1 ± 1.2) and 5 minutes (6.3 ± 1.4) compared to non-asphyxiated neonates ($p < 0.001$). Table-1

Univariate logistic regression analysis revealed several significant risk factors for birth asphyxia. Maternal hypertension (OR = 2.5, 95% CI: 1.8–3.4; n=375), diabetes (OR = 2.1, 95% CI: 1.5–2.9; n=200), and inadequate antenatal care (OR = 3.0, 95% CI: 2.2–4.1; n=500) were strongly associated with birth asphyxia. Prolonged labor (OR = 2.8, 95% CI: 2.0–3.9; n=375) and cesarean section (OR = 2.3, 95% CI: 1.7–3.1; n=500) were significant obstetric risk factors. Among fetal factors, meconium-stained amniotic fluid (OR = 3.5, 95% CI: 2.6–4.7; n=300) and low birth weight (OR = 2.7, 95% CI: 1.9–3.8; n=200) were strongly associated with birth asphyxia.

Multivariate logistic regression analysis confirmed the independent association of maternal hypertension (aOR = 2.2, 95% CI: 1.6–3.0; n=375), inadequate antenatal care (aOR = 2.5, 95% CI: 1.8–3.5; n=500), prolonged labor (aOR = 2.4, 95% CI: 1.7–3.4; n=375), and meconium-stained amniotic fluid (aOR = 3.0, 95% CI: 2.2–4.1; n=300) with birth asphyxia. Table-2

Table 1: Characteristics of the Study Population

Variable	Birth asphyxia (n=250)	No birth asphyxia (n=2250)	Total (n=2500)	p-value
Maternal Age (years)	29.1 ± 5.5	28.4 ± 5.1	28.5 ± 5.2	0.06
Parity (Multiparous)	150 (60%)	1,475 (66%)	1,625 (65%)	0.08
Hypertension	63 (25%)	312 (14%)	375 (15%)	<0.001
Diabetes	38 (15%)	162 (7%)	200 (8%)	<0.001
Anemia	45 (18%)	255 (11%)	300 (12%)	0.002

Variable	Birth asphyxia (n=250)	No birth asphyxia (n=2250)	Total (n=2500)	p-value
Inadequate Antenatal Care	88 (35%)	412 (18%)	500 (20%)	<0.001
Prolonged Labor	75 (30%)	300 (13%)	375 (15%)	<0.001
Cesarean Section	75 (30%)	425 (18%)	500 (20%)	<0.001
Meconium-Stained Fluid	63 (25%)	237 (10%)	300 (12%)	<0.001
Low Birth Weight	38 (15%)	162 (7%)	200 (8%)	<0.001
Apgar Score (1 min)	4.1 ± 1.2	6.5 ± 1.4	6.3 ± 1.5	<0.001
Apgar Score (5 min)	6.3 ± 1.4	8.3 ± 1.1	8.0 ± 1.3	<0.001

Table 2: Univariate and Multivariate Analysis of Risk Factors for Birth Asphyxia

Risk Factor	Univariate OR (95% CI)	Multivariate aOR (95% CI)
Maternal Hypertension	2.5 (1.8–3.4)	2.2 (1.6–3.0)
Diabetes	2.1 (1.5–2.9)	1.8 (1.3–2.6)
Inadequate Antenatal Care	3.0 (2.2–4.1)	2.5 (1.8–3.5)
Prolonged Labor	2.8 (2.0–3.9)	2.4 (1.7–3.4)
Cesarean Section	2.3 (1.7–3.1)	2.0 (1.5–2.8)
Meconium-Stained Fluid	3.5 (2.6–4.7)	3.0 (2.2–4.1)
Low Birth Weight	2.7 (1.9–3.8)	2.3 (1.6–3.3)

DISCUSSION

The findings of this study highlight the significant impact of maternal, obstetric, and fetal risk factors on the occurrence of birth asphyxia in term neonates. The prevalence of birth asphyxia in our study was 10%, which is consistent with rates reported in other low- and middle-income countries (11).

In our study, maternal hypertension emerged as a significant independent risk factor for birth asphyxia (aOR = 2.2, 95% CI: 1.6–3.0). This finding aligns with previous research, such as a study by Akuze et al. (12), which reported that hypertensive disorders during pregnancy increase the risk of placental insufficiency, thereby compromising fetal oxygenation. Similarly, inadequate antenatal care was strongly associated with birth asphyxia (aOR = 2.5, 95% CI: 1.8–3.5), consistent with evidence from Ayebare et al. (13), who emphasized the importance of regular prenatal visits in identifying and managing high-risk pregnancies. Additionally, maternal infections, such as chorioamnionitis, were significantly associated with birth asphyxia in our study, likely due to their role in triggering inflammatory responses that impair fetal oxygenation. Our study identified prolonged labor (aOR = 2.4, 95% CI: 1.7–3.4) and cesarean section (aOR = 2.0, 95% CI: 1.5–2.8) as critical obstetric risk factors for birth asphyxia. Prolonged labor can lead to fetal distress due to prolonged compression of the umbilical cord and reduced placental perfusion, as highlighted by Hughes et al. (14). Similarly, cesarean sections, particularly emergency procedures, were associated with a higher risk of asphyxia, likely due to delays in decision-making and preparation for delivery. This finding is consistent with a study by Busumani et al. (15), which reported that emergency cesarean sections are a significant risk factor for birth asphyxia in LMICs.

Among fetal factors, meconium-stained amniotic fluid (aOR = 3.0, 95% CI: 2.2–4.1) and low birth weight (aOR = 2.3, 95% CI: 1.6–3.3) were significantly associated with birth asphyxia in our study. Meconium aspiration can obstruct the neonatal airways, leading to hypoxia and respiratory distress, as reported by Desalew et al (16). Low birth weight, often indicative of intrauterine growth restriction (IUGR), reflects compromised fetal reserves, making neonates more vulnerable to asphyxia during labor and delivery. These findings are consistent with global data, such as those from Kurinczuk et al (17), who highlighted the role of fetal conditions in the pathogenesis of birth asphyxia.

The results of this study have important implications for clinical practice. Early identification and management of maternal hypertension, diabetes, and infections during pregnancy can significantly reduce the risk of birth asphyxia. Strengthening antenatal care services and ensuring timely access to skilled

birth attendants are critical steps in preventing prolonged labor and emergency cesarean sections. Additionally, intrapartum monitoring protocols should be optimized to detect fetal distress early and facilitate prompt intervention.

One of the strengths of this study is its large sample size (n=2,500), which provides robust statistical power to detect significant associations. Additionally, the inclusion of maternal, obstetric, and fetal risk factors allowed for a comprehensive analysis of the determinants of birth asphyxia. However, the study has some limitations. Its retrospective design limits the ability to establish causal relationships, and the findings may not be generalizable to rural or low-resource settings outside the study area.

CONCLUSION

This study identifies maternal hypertension, inadequate antenatal care, prolonged labor, and meconium-stained amniotic fluid as key risk factors for birth asphyxia in term neonates. Addressing these factors through targeted interventions and improved intrapartum care can significantly reduce the burden of birth asphyxia and its associated complications. Future research should focus on prospective studies to further elucidate the causal pathways and explore interventions to mitigate these risks.

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