

Prevalence of Birth Asphyxia and Associated Factors Among Live Births at Public Hospitals in Sana'a City, Yemen

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Abstract

Background: Birth asphyxia remains a major public health problem worldwide and is a leading cause of neonatal morbidity and mortality, particularly in low- and middle-income countries (1,2). Globally, birth asphyxia contributes to approximately 23% of neonatal deaths and is associated with long-term neurodevelopmental disabilities among survivors (3,4). In Yemen, despite high neonatal mortality, evidence on the prevalence of birth asphyxia and its associated factors is scarce.

Objective: To determine the prevalence of birth asphyxia and identify associated socio-demographic, antepartum, intrapartum, and neonatal factors among live births at public hospitals in Sana'a City, Yemen.

Methods: A descriptive cross-sectional study was conducted among 452 mothers and their newborns delivered at three major public hospitals in Sana'a City from February to May 2024. Data were collected using a structured and pretested questionnaire. Birth asphyxia was defined using the fifth-minute Apgar score, with a score <7 indicating asphyxia (5,6). Bivariate and multivariable logistic regression analyses were performed to identify factors independently associated with birth asphyxia.

Results: The prevalence of birth asphyxia among live births was 19.5%. Multiparity (AOR = 2.34), cesarean section delivery (AOR = 3.16), and very low birth weight (<1500 g) (AOR = 2.83) were independently associated with birth asphyxia.

Conclusion: Birth asphyxia remains a significant neonatal health problem in Sana'a City. Strengthening antenatal care, improving intrapartum monitoring, and enhancing neonatal resuscitation practices are essential to reduce preventable neonatal morbidity and mortality.

Keywords: Birth asphyxia; Apgar score; neonatal mortality; Yemen; perinatal factors

1. Introduction

Birth asphyxia is a major public health problem worldwide and represents one of the leading causes of neonatal morbidity and mortality, particularly in resource-limited settings (3,4). It is commonly defined as the failure of a newborn to initiate and sustain spontaneous breathing at birth (7). Clinically, the Apgar score is widely used to assess the severity of birth asphyxia, with a score below seven at the fifth minute of life indicating asphyxia (5,6). Moderate birth asphyxia is characterized by Apgar scores of four to six, while severe asphyxia is defined by scores of zero to three and is associated with a high risk of multi-organ dysfunction and mortality (8,9).

Pathophysiologically, birth asphyxia results from impaired gas exchange leading to hypoxemia, hypercapnia, and metabolic acidosis. Prolonged hypoxia and ischemia can cause cardiovascular compromise, reduced cerebral blood flow, and irreversible damage to vital organs, particularly the brain (10,8). Survivors of severe birth asphyxia are at increased risk of long-term neurological sequelae, including cerebral palsy, epilepsy, cognitive impairment, and developmental delay (8,11).

Globally, approximately 23% of all neonatal deaths are attributable to birth asphyxia, accounting for nearly one million deaths annually (3,4). The burden is disproportionately higher in low-income countries, where limitations in antenatal care, skilled birth attendance, and neonatal resuscitation services persist (12,11). In developing countries,

neonatal deaths constitute a substantial proportion of under-five mortality, with birth asphyxia ranking among the top three causes alongside prematurity and infections (3).

Birth asphyxia is a multifactorial condition, with contributing factors arising during the antepartum, intrapartum, and neonatal periods (13,14). Antepartum factors include maternal anemia, hypertensive disorders of pregnancy, infections, and inadequate antenatal care utilization (5,2). Intrapartum factors such as prolonged labor, malpresentation, premature rupture of membranes, fetal distress, and emergency cesarean section have been strongly associated with increased risk of birth asphyxia (7,12). Neonatal factors, particularly prematurity and low birth weight, further increase vulnerability due to immature respiratory and neurological systems (9,15).

In Yemen, prolonged conflict has severely weakened the health system, compromising access to quality maternal and neonatal care. Despite high neonatal mortality rates, there is a clear absence of published studies addressing the prevalence of birth asphyxia and its associated factors at the national level. This lack of evidence limits the development of targeted interventions and policies aimed at improving neonatal outcomes. Therefore, this study was conducted to determine the prevalence of birth asphyxia and identify associated factors among live births at public hospitals in Sana'a City, Yemen.

2. Materials and Methods

2.1 Study Design and Setting

A descriptive cross-sectional study was conducted to assess the prevalence of birth asphyxia and its associated factors among live births at public hospitals in Sana'a City, Yemen. The study was carried out from February to May 2024. Sana'a City was selected

because it hosts the largest public maternity hospitals in the country and serves as a major referral center for obstetric and neonatal care.

The study was conducted in three major public hospitals: Al-Sabeen Maternity and Child Hospital, Al-Gumhouri Teaching Hospital, and Palestine Maternity and Childhood Hospital. These hospitals collectively manage the majority of institutional deliveries in Sana'a City and receive high-risk obstetric referrals from both urban and rural areas.

2.2 Study Population

The study population consisted of mothers who delivered live newborns and their infants at the selected public hospitals during the study period.

2.3 Inclusion and Exclusion Criteria

Inclusion criteria:

Mothers who delivered live newborns with a gestational age of 28 weeks or more and a birth weight greater than 1000 grams were included in the study. Both singleton and twin deliveries were eligible.

Exclusion criteria:

Newborns with major congenital anomalies, newborns with Apgar score depression attributable to maternal anesthesia or narcotic drug exposure, newborns delivered before 28 weeks of gestation, and newborns with birth weight less than 1000 grams were excluded from the study, in accordance with similar studies on birth asphyxia (5,13).

2.4 Sample Size Determination

The sample size was calculated using OpenEpi version 3.01, with a 95% confidence level and a margin of error of 5% (16). Due to the absence of prior studies on birth asphyxia in

Yemen, an expected prevalence of 50% was assumed to maximize the sample size. After adding a 20% non-response rate, the final sample size was determined to be 461 mother–newborn pairs. A total of 452 participants were successfully included in the final analysis, yielding a response rate of 98.1%.

2.5 Sampling Technique

A two-stage sampling technique was employed. In the first stage, proportional allocation to size (PPS) was used to distribute the sample among the three selected hospitals based on their annual delivery volumes. In the second stage, systematic random sampling was applied using daily delivery registration logs from each hospital until the required sample size was achieved.

2.6 Data Collection Tool and Procedures

Data were collected using a structured and pretested questionnaire adapted from previous studies conducted in low-resource settings (1,2). The questionnaire consisted of sections covering socio-demographic characteristics, antepartum factors, intrapartum factors, neonatal characteristics, and Apgar score assessment.

The Apgar score was assessed at the fifth minute after birth using five standard components: heart rate, respiratory effort, muscle tone, reflex irritability, and skin color. Each component was scored from zero to two, with a total score ranging from zero to ten. A fifth-minute Apgar score of less than seven was used to define birth asphyxia (5,6).

2.7 Data Quality Assurance

To ensure data quality, the questionnaire was pretested on 10% of the calculated sample size prior to the actual data collection. Data collectors received training on study

objectives, data collection procedures, and standardized Apgar score assessment.

Continuous supervision and daily review of completed questionnaires were conducted to ensure completeness and consistency of the data.

2.8 Data Processing and Statistical Analysis

Data were coded, entered, cleaned, and analyzed using the Statistical Package for Social Sciences (SPSS) version 26 (17). Descriptive statistics were used to summarize socio-demographic, antepartum, intrapartum, and neonatal characteristics.

Bivariate analysis was conducted to assess the association between independent variables and birth asphyxia. Variables with a p-value less than 0.25 in the bivariate analysis were entered into a multivariable logistic regression model to control for potential confounders. Adjusted odds ratios (AOR) with 95% confidence intervals were calculated, and statistical significance was declared at $p < 0.05$.

2.9 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the Faculty of Medical Sciences, 21 September University for Applied Medical Sciences. Official permission was secured from the administrations of the selected hospitals. Written informed consent was obtained from all participating mothers after explaining the purpose of the study. Confidentiality was ensured by anonymizing all collected data.

3. Results

3.1 Socio-demographic Characteristics of Mothers

A total of 452 mother–newborn pairs were included in the study. The mean age of the

mothers was 27.6 ± 6.1 years. Most mothers were in the age group of 25–30 years (34.5%), followed by those aged 21–25 years (19.5%) and 30–35 years (18.1%). Mothers aged above 35 years constituted 10.4% of the study population, while those aged 15–20 years accounted for 17.5%.

Maternal age showed a statistically significant association with birth asphyxia. The prevalence of birth asphyxia was highest among mothers aged above 35 years (34.0%), followed by those aged 30–35 years (23.2%). Lower prevalence was observed among mothers aged 15–20 years (10.1%) and 21–25 years (14.8%), and this association was statistically significant ($p = 0.012$), consistent with findings reported in similar low-resource settings (1,13).

Regarding parity, 258 mothers (57.1%) were multiparous, while 194 (42.9%) were primiparous. Birth asphyxia occurred significantly more frequently among multiparous mothers (24.8%) compared to primiparous mothers (12.4%) ($p = 0.001$), in line with previous studies conducted in Ethiopia (2,14).

Most mothers (79.2%) resided in urban areas, whereas 20.8% lived in rural areas. Although a higher proportion of birth asphyxia was observed among rural residents (22.3%) compared to urban residents (18.7%), this difference was not statistically significant.

3.2 Antepartum-Related Factors

The majority of mothers (86.1%) reported attending antenatal care during their current pregnancy. However, only 37.6% completed four or more antenatal visits, while 48.5% attended fewer than four visits.

Antepartum complications were reported by 245 mothers (54.2%). The most frequently reported complications included preeclampsia (20.1%), maternal infections (14.6%), and anemia (10.0%). The presence of antepartum complications was significantly associated with birth asphyxia, with a higher prevalence observed among mothers who experienced complications compared to those who did not ($p < 0.001$), a finding consistent with earlier studies (5,12).

Substance use during pregnancy was reported by 61.3% of the mothers. Khat chewing was the most common substance used (45.4%), followed by tobacco use (40.0%). Although a higher prevalence of birth asphyxia was observed among newborns of mothers who used substances during pregnancy, this association did not remain statistically significant after adjustment for confounding factors.

3.3 Intrapartum-Related Factors

Regarding fetal presentation, 391 deliveries (86.5%) occurred with vertex presentation, while 61 deliveries (13.5%) involved malpresentation. Birth asphyxia was significantly more frequent among newborns delivered with malpresentation (27.9%) compared to vertex presentation (17.4%) ($p = 0.029$), consistent with previous reports (7,12).

In terms of labor duration, 243 mothers (53.8%) experienced normal labor, whereas 195 mothers (43.1%) had prolonged labor. Birth asphyxia was significantly more common among newborns delivered after prolonged labor (24.6%) compared to those delivered after normal labor (15.2%) ($p = 0.014$).

Concerning the mode of delivery, spontaneous vaginal delivery accounted for 48.0% of births, while cesarean section constituted 42.5%. Birth asphyxia occurred more frequently

among newborns delivered by cesarean section (25.0%) compared to those delivered vaginally (14.7%), and this association was statistically significant ($p = 0.037$), as also observed in other hospital-based studies (15,2).

Meconium-stained amniotic fluid was observed in 30.1% of deliveries. Although a higher proportion of birth asphyxia was noted among newborns delivered with meconium-stained fluid, this association did not reach statistical significance.

3.4 Neonatal Characteristics

Male newborns slightly outnumbered female newborns; however, neonatal sex was not significantly associated with birth asphyxia. Birth weight demonstrated a strong association with birth asphyxia. Newborns with very low birth weight (<1500 g) accounted for 32.1% of the study population and had the highest prevalence of birth asphyxia (31.7%). Newborns with birth weight between 1500 and 2499 g had a prevalence of 16.6%, while those with birth weight ≥ 2500 g had the lowest prevalence (6.4%). This association was statistically significant ($p < 0.001$), consistent with findings from previous studies (9,8). Gestational age was also significantly associated with birth asphyxia. Preterm newborns (25.4%) had a higher prevalence of birth asphyxia (28.7%) compared to full-term newborns (16.5%) ($p = 0.007$). Additionally, 131 newborns (29.0%) required resuscitation at birth. Birth asphyxia was significantly more common among newborns who required resuscitation compared to those who did not (35.1% versus 12.9%; $p < 0.001$).

3.5 Prevalence of Birth Asphyxia

The overall prevalence of birth asphyxia among live births included in the study was 19.5%. This finding indicates that nearly one in five newborns delivered at public hospitals in Sana'a City experienced birth asphyxia during the study period.

3.6 Multivariable Logistic Regression Analysis

Variables that showed an association with birth asphyxia in the bivariate analysis were entered into a multivariable logistic regression model. After adjusting for potential confounding factors, three variables remained independently associated with birth asphyxia.

Multiparity was significantly associated with birth asphyxia, with multiparous mothers having more than twice the odds of delivering an asphyxiated newborn compared to primiparous mothers (AOR = 2.34; 95% CI: 1.42–3.87). Newborns delivered by cesarean section had significantly higher odds of birth asphyxia compared to those delivered by spontaneous vaginal delivery (AOR = 3.16; 95% CI: 1.78–5.62). Very low birth weight (<1500 g) was also identified as a strong independent predictor of birth asphyxia (AOR = 2.83; 95% CI: 1.65–4.85).

The final model demonstrated good fit, as indicated by the Hosmer–Lemeshow goodness-of-fit test ($p > 0.05$).

4. Discussion

This study assessed the prevalence of birth asphyxia and identified associated maternal, intrapartum, and neonatal factors among live births at public hospitals in Sana'a City, Yemen. The overall prevalence of birth asphyxia was 19.5%, indicating a substantial burden of neonatal morbidity in the study setting.

The prevalence observed in this study is considerably higher than that reported in high-income countries, where rates range from 1 to 5 per 1,000 live births, but is comparable

with findings from low-resource settings such as Ethiopia and Pakistan, where prevalence rates between 10% and 25% have been documented (1,13,2). This similarity may be attributed to shared health-system challenges, including limited access to quality antenatal care, delayed intrapartum referral, and inadequate neonatal resuscitation capacity.

4.1 Socio-demographic Factors

Maternal age demonstrated a statistically significant association with birth asphyxia, with higher prevalence observed among mothers aged above 35 years and those at the lower age extremes. Extremes of maternal age have been consistently associated with adverse perinatal outcomes, including birth asphyxia, due to increased obstetric complications, biological immaturity, and comorbidities (5,12).

Parity emerged as a significant independent predictor of birth asphyxia. Multiparous mothers had more than twice the odds of delivering an asphyxiated newborn compared to primiparous mothers. Similar findings have been reported in studies conducted in Ethiopia and other low-income settings, where repeated pregnancies may lead to maternal nutritional depletion and cumulative obstetric risks (14,2).

4.2 Antepartum Factors

Antepartum complications were common in the study population and showed a strong association with birth asphyxia. Conditions such as preeclampsia, maternal infections, and anemia have been widely documented as risk factors for impaired uteroplacental perfusion and fetal hypoxia (5,7). Although antenatal care attendance was relatively high, the high prevalence of complications suggests gaps in the quality and timeliness of antenatal services.

Substance use during pregnancy, particularly khat chewing and tobacco smoking, was frequently reported. While substance use did not remain significant in multivariable analysis, previous studies have highlighted the adverse effects of stimulant substances on placental blood flow and fetal oxygenation, underscoring the need for preventive counseling during antenatal care (12).

4.3 Intrapartum Factors

Intrapartum-related factors played a critical role in the occurrence of birth asphyxia. Malpresentation and prolonged labor were significantly associated with birth asphyxia, consistent with findings from multiple studies in low-resource settings (7,1). These conditions may compromise fetal oxygenation due to cord compression, uterine exhaustion, and delayed delivery.

Mode of delivery was identified as a strong independent predictor of birth asphyxia. Newborns delivered by cesarean section had significantly higher odds of birth asphyxia compared to those delivered vaginally. This finding is consistent with previous studies suggesting that emergency cesarean sections are often performed in response to fetal distress or obstructed labor, rather than being a direct cause of asphyxia (15,2).

4.4 Neonatal Factors

Neonatal characteristics, particularly birth weight and gestational age, were strongly associated with birth asphyxia. Very low birth weight newborns had significantly higher odds of birth asphyxia compared to those with normal birth weight. This finding aligns with existing literature indicating that low birth weight infants are more vulnerable to hypoxia due to immature respiratory control and limited physiological reserves (9,8).

Preterm newborns were also at increased risk of birth asphyxia. Prematurity is closely linked to surfactant deficiency, respiratory instability, and poor thermoregulation, all of which contribute to impaired transition at birth (8).

5. Conclusion

This study revealed a high prevalence of birth asphyxia (19.5%) among live births at public hospitals in Sana'a City, Yemen, indicating a significant burden of neonatal morbidity in the study setting. Multiparity, cesarean section delivery, and very low birth weight were identified as independent predictors of birth asphyxia.

The findings highlight critical gaps in maternal and neonatal care, particularly in antenatal risk detection, intrapartum monitoring, and immediate neonatal management. Strengthening the quality of antenatal care, ensuring timely identification and management of obstetric complications, and improving intrapartum surveillance through standardized use of partographs are essential to reduce the occurrence of birth asphyxia.

In addition, enhancing neonatal resuscitation skills among healthcare providers and ensuring the availability of essential resuscitation equipment at delivery sites are crucial interventions. Addressing preventable risk factors such as maternal anemia, hypertensive disorders of pregnancy, and prematurity should be prioritized within national maternal and neonatal health strategies.

These findings provide valuable baseline evidence to inform policy-makers and healthcare planners in Yemen and support the development of targeted interventions aimed at

improving neonatal survival and achieving sustainable reductions in preventable neonatal deaths.

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