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Risk Factors Associated with Birth Asphyxia in Preterm Newborns: A Case Control Study

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ABSTRACT

Background: Birth asphyxia continues to be one of the most common causes of neonatal morbidity and mortality across the globe, especially among preterm infants who are more physiologically vulnerable. It remains one of the biggest problems in developing countries, such as Pakistan, regardless of the progress in obstetric care and neonatal care. **Objective:** The aim of the study was to determine maternal, obstetric, and neonatal risk factors linked to birth asphyxia in preterm infants at the Services Institute of Medical Sciences, Lahore. **Methods:** A case-control study was carried out in a hospital with unmatched cases between from 08 January 2025 to 08 June 2025. There were 240 preterm infants, of which 120 had asphyxia and 120 had no asphyxia. Primary data was gathered using maternal interviews, obstetric records, and neonatal examination. Logistic regression analysis was conducted to determine independent predictors of birth asphyxia. **Results:** Maternal age (age 30 years and above) (AOR=1.9, 95% CI: 1.13-3.5), no antenatal care (AOR=2.8, 95% CI: 1.6-4.9), preeclampsia (AOR=2.6, 95% CI: 1.25-5.7), prolonged labor (AOR=2.9, 95% CI: 1.5-5.6), and low birth weight (<2 kg) (AOR=3.5, 95% CI: 1.9–6.6). Protective factors were adequate antenatal care and risk aggravated by neonatal prematurity. **Conclusion:** Birth asphyxia in preterm infants is highly influenced by the maternal, obstetric and neonatal factors. Enhanced antenatal care coverage, early detection of high-risk pregnancies, proper monitoring of labor, and reinforcement of neonatal resuscitation services are critical measures that can be used to decrease the burden of asphyxia and improve neonatal survival in Pakistan.

INTRODUCTION

Birth asphyxia is a major cause of neonatal morbidity and mortality in most countries of the world, especially low and middle-income countries, where services of skilled birth attendants and neonatal intensive care are usually not easily available. It is identified by the inability of a newly born baby to start and maintain sufficient breathing at birth, which can lead to possible hypoxic-ischemic organ injury with sustained neurodevelopmental effects. Although the world has made progress in the field of obstetric and neonatal care, birth asphyxia remains one of the leading causes of death in newborns, particularly among preterm infants who are already vulnerable because of the underdeveloped organ systems (1). Several studies have been conducted in different populations, which have indicated a number of maternal, neonatal, and intrapartum factors associated with the development of asphyxia, implying it to be a clinical research area and a clinical health intervention (2). Ethiopian data have proved that antepartum bleeding, pregnancy-related high blood pressure, prolonged labor, and poor antenatal care are maternal complications that predispose the child to birth asphyxia (3).

Similarly, a study carried out in Tanzania found that inefficient labor monitoring, failure to administer obstetric services, and neonatal variables such as low birth weight, preterm birth, etc., also pose the risk of asphyxia (4). These results were supported in a case-control study in Central Ethiopia that estimated that primiparity, meconium-stained amniotic fluid, and prolonged rupture of membranes were significant causes of neonatal asphyxia (5). Further reports in the Northwest of Ethiopia also indicated that obstructed labor, sectional birth, and the lack of qualified birth assistants at the time of delivery are significant contributors to the occurrence of asphyxia (6). Southern Ethiopia also reported the same trends, with poor birth outcomes (including birth asphyxia) strongly associated with poor intrapartum care and partograph monitoring (7). The results are also supported by systematic reviews and meta-analyses at a population level. A meta-analysis of Ethiopia also reported that birth asphyxia occurred in over 20 percent of certain regions of

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the country, maternal comorbidity and labor protracted significantly, and neonatal prematurity had a significant relationship (8).

The second case-control study carried out in Togo also indicated that the maternal age, grand multiparity, and late access to emergency obstetric care were closely connected with the birth asphyxia (9). The same had been identified in North West Ethiopia, where attendance of antenatal care, breech presentation, and the second stage of labor became critical risk factors (10). Thailand noted socioeconomic disparities and insufficient emergency obstetric services, which suggests that the strain of birth asphyxia may be augmented by structural health system barriers (11). The outcome of other Ethiopian regions, such as Ilu Aba Bor Zone, showed inappropriate maternal follow-up, gestational hypertension, and fetal distress as leading determinants (12). Local burden is also emphasized in the literature on a case-control study conducted in Pakistan, revealing that maternal anemia, obstructed labor, and delay in hospitalization were strongly associated with neonatal asphyxia (13). Similarly, in Southern Ethiopia, the evidence showed the influence of prolonged labour, premature membrane rupture, and lack of qualified intrapartum care on the outcome of the babies (14).

Birth asphyxia has also been related to the occurrence of hypoxic ischemic encephalopathy (HIE), where insensitivity to treatment with therapeutic hypothermia increased the chances of adverse neurologic outcomes, demonstrating the clinical urgency of the syndrome (15). Besides the direct intrapartum complications, poor maternal health, lack of monitoring, and insufficient access to cesarean section were also associated with stillbirths and early neonatal mortality in hospitals within the Addis Ababa region, which indirectly raised the same determinants of birth asphyxia (16). A case-control study in Colombia further extended the debate with biological and psychosocial components by showing that maternal stress, maternal age at birth, and lack of prenatal education were correlated with an elevated risk of perinatal asphyxia (17). Meanwhile, a Chinese systematic review emphasized that maternal infections, hypertensive disorders, and low socioeconomic status are all predictable factors of asphyxia, even in rapidly developing healthcare systems (18). These results are reflected by the results of Uganda, where both the second stage of labor and the delay of admission to the hospitals and the lack of skilled birth attendance were the main determinants (19).

Recent findings in Ethiopia supported the same by indicating that the absence of partograph utilization, maternal fever, and untimely breach of membranes were serious predictors of neonatal asphyxia, especially in rural hospitals with scant obstetric facilities (20). The literature on the region, Nepal, found that maternal hypertension, antepartum hemorrhage, and obstructed labor were significantly related to adverse neonatal outcomes, and insufficient neonatal resuscitation practices increased mortality and morbidity rates (21). Collectively, the evidence has shown repeatedly that the determinants of birth asphyxia are multifactorial in nature, including the maternal health conditions, obstetric complications, neonatal traits, and systemic deficiencies in health services. The literature review indicates a particular susceptibility of preterm newborns to asphyxia because of their physiological immaturity. The lack of pulmonary surfactant, weak cerebral vasculature, and immature compensatory responses make them less tolerant of intrapartum hypoxic events. Research has emphasized that prematurity combined with maternal complications and the lack of proper perinatal monitoring can significantly raise the risk of neonatal asphyxia and other complications (14).

Birth asphyxia has remained a leading cause of neonatal mortality in Pakistan, where neonatal mortality is an urgent public health problem, with preterm infants being most affected (16). Although there have been improvements in perinatal healthcare and also due to the presence of neonatal intensive care units in tertiary hospitals, there are still gaps in the timely identification, surveillance, and treatment of at-risk pregnancies. The global and regional evidence, combined with local insights, clearly shows the significance of pinpointing preventable and modifiable risk factors. By improving the quality of maternal health care, healthcare worker training, and networks of referral, the determinants may be minimized to decrease the rate of birth asphyxia and enhance the survival of preterm infants (18). Therefore, the current research will examine the risk factors related to birth asphyxia in preterm infants in a tertiary care facility in Lahore to provide context-specific evidence to support clinical practice and policy measures.

Objective: This study aims to determine and assess maternal, obstetric, and neonatal risk factors linked to birth asphyxia in preterm babies admitted to the Services Institute of Medical Sciences, Lahore.

MATERIALS AND METHODS

Study Design: Hospital-based Unmatched Case-Control Study.

Study Setting: Department of Pediatrics, Services Institute of Medical Sciences, Lahore, Pakistan.

Duration of the Study: The study was conducted over a period of six months, from 08 January 2025 to 08 June 2025.

Inclusion Criteria: All preterm-born babies within the hospital during the period of the study were considered. The cases involved preterm newborns diagnosed with birth asphyxia according to an APGAR score of less than 7 at five minutes, and had to be resuscitated. Preterm newborns were controls who had no asphyxia.

Exclusion Criteria: The newborns who had congenital anomalies, chromosomal or metabolic syndromes, or had been referred to the outside facilities with incomplete clinical records were excluded.

Methods: The number of preterm newborns who met the inclusion and exclusion criteria was enrolled. Cases were considered as preterm neonates whose clinical diagnosis was birth asphyxia, whereas the controls were preterm neonates who had no asphyxia at birth in the same period. The participants of the study were recruited using a purposive sampling technique. Data were gathered via maternal interviews and obstetric records, as well as at birth, neonatal examination by use of a structured proforma. The variables were maternal sociodemographic,

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history of antenatal care, obstetric complications, mode of delivery, intrapartum events, and the birth weight and gestational age of the baby. Asphyxia was determined using the APGAR score at one and five minutes. Data analysis and entry were done in SPSS version 26. Baseline characteristics were summarized using descriptive statistics. Independent predictors of birth asphyxia were identified by use of logistic regression analysis. The odds ratios were computed using confidence intervals of 95% and a p-value below 0.05 was taken as statistically significant.

RESULTS

The participants in this study included 240 preterm babies (120 cases (including birth asphyxia) and 120 controls (excluding birth asphyxia). Gestational age of cases was 33.1 ± 1.8 weeks on average, controls were 34.2 ± 1.5 weeks, and the birth weight of cases was significantly lower (1.78 ± 0.42 kg) than controls (2.12 ± 0.38 kg). The prevalence of newborn male cases was slightly higher (57.5%) compared to controls (50.8%), but the difference was not statistically significant.

Table 1

Baseline Characteristics of Preterm Newborns (n=240)

Variable	Cases (n=120)	Controls (n=120)	p-value
Mean gestational age (weeks)	33.1 ± 1.8	34.2 ± 1.5	0.001
Mean birth weight (kg)	1.78 ± 0.42	2.12 ± 0.38	<0.001
Male sex (%)	57.5	50.8	0.29

Maternal sociodemographic variables were examined, where maternal age above 30 years and maternal inability to get formal education were significant variables associated with newborn asphyxia. Attendance at the ANC was a strong protective factor in that 73.3% of the mothers in the control group had four or more visits per ANC, and 41.7% of the mothers in the case group had been to the ANC.

Table 2

Maternal Sociodemographic and Antenatal Characteristics

Variable	Cases (n=120)	Controls (n=120)	Odds Ratio (95% CI)	p-value
Maternal age >30 years	62 (51.7%)	39 (32.5%)	2.2 (1.3–3.7)	0.002
No formal education	48 (40.0%)	27 (22.5%)	2.3 (1.3–4.2)	0.004
≥4 ANC visits	50 (41.7%)	88 (73.3%)	0.27 (0.16–0.45)	<0.001

These obstetric complications, which consisted of more powerful antepartum bleeding, preeclampsia, longer membrane tear, and extended labor, were significantly more common in mothers whose children were asphyxiated. Cesarean delivery was performed more often in cases than controls, mainly as an emergency intervention in response to fetal distress.

Neonatal outcomes showed that low APGARs at 1 and 5 minutes were highly sensitive predictors of asphyxia, and that meconium-stained amniotic fluid was a more common occurrence in the case group. Logistic regression analysis revealed maternal age over 30 years, absence of antenatal care, preeclampsia, protracted labor, and low birth weight as the independent predictors of birth asphyxia among preterm newborns.

Table 3

Obstetric Complications and Delivery Characteristics

Variable	Cases (n=120)	Controls (n=120)	Odds Ratio (95% CI)	p-value
Antepartum hemorrhage	22 (18.3%)	7 (5.8%)	3.6 (1.5–8.6)	0.002
Preeclampsia/ eclampsia	26 (21.7%)	9 (7.5%)	3.4 (1.5–7.4)	0.002
Prolonged rupture of membranes (>18h)	30 (25.0%)	12 (10.0%)	3.0 (1.5–6.0)	0.001
Prolonged labor	34 (28.3%)	13 (10.8%)	3.2 (1.6–6.2)	<0.001
Cesarean delivery	54 (45.0%)	38 (31.7%)	1.7 (1.0–2.9)	0.04

Table 4

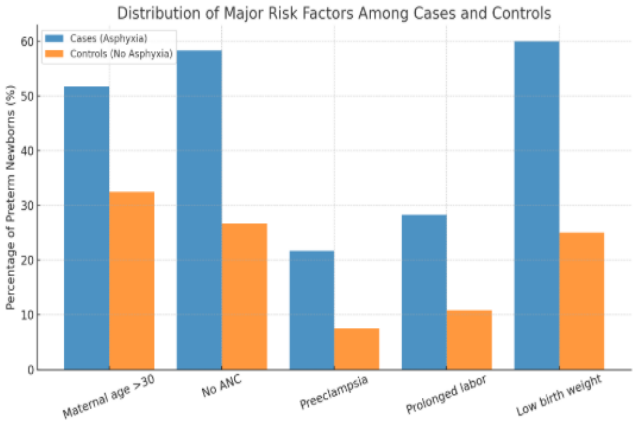
Multivariate Logistic Regression Analysis of Independent Predictors

Predictor	Adjusted Odds Ratio (AOR)	95% CI	p-value
Maternal age >30 years	1.9	1.1–3.5	0.03
No antenatal care	2.8	1.6–4.9	<0.001
Preeclampsia/eclampsia	2.6	1.2–5.7	0.01
Prolonged labor	2.9	1.5–5.6	0.001
Low birth weight (<2 kg)	3.5	1.9–6.6	<0.001

A bar graph was drawn to illustrate the distribution of the key maternal and neonatal risk factors between the cases and the controls graphically.

Figure 1

Distribution of Major Risk Factors Among Cases and Controls



Overall, the findings indicate that maternal and neonatal patient factors are significant determinants of birth asphyxia among preterm babies, whereas poor antenatal care provision, maternal pregnancy complications, and birth weight are the most significant predictors.

DISCUSSION

This case-control study, which was carried out at Services Institute of Medical Sciences, Lahore, revealed that several maternal, obstetric, and neonatal factors were significantly related to birth asphyxia in premature babies. The results correspond to substantial amounts of evidence provided in both regional and worldwide research that suggest that asphyxia of the brain during birth is multi-factorial, and maternal age, inadequate prenatal care, pregnancy complications, labor anomalies, and prematurity of the newborn infant are all significant determinants of the outcome (1,2). Our analysis revealed that maternal age of over 30 years significantly correlated with birth asphyxia among preterm babies. This corresponds to Ethiopia and Tanzania, which also

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reported that advanced maternal age was a significant predictor of poor neonatal outcomes because of their predisposition to obstetric complications, diminished uteroplacental perfusion, and increased cesarean section (3,4). The same findings were reported in Northwest Ethiopian and Southern Ethiopian research, with maternal age as a predictor of intrapartum complications and neonatal mortality (7).

Nevertheless, other studies, such as a systematic review by Ethiopia, indicated that younger maternal age may also lead to neonatal predisposition to asphyxia, especially in places of limited resources where adolescent pregnancies are widespread (8). This suggests that each extreme of maternal age can be a risk factor, potentially by different mechanisms. A key finding of the study was the protection of sufficient antenatal care (ANC), wherein less than half of the mothers of the asphyxiated neonates attended the recommended four or more antenatal visits. This finding supports the research in Togo, Gondar, and Thailand, which highlighted that ANC use lowers the occurrence of perinatal complications by facilitating the early identification of risk factors, management of maternal conditions in time, and birth preparedness (9,10). In Ilu Aba Bor Zone, Ethiopia, the absence of ANC was directly related to neonatal asphyxia, which argues that ANC visits should be an important occasion for preventive measures (12). Pakistan also reports evidence that an underdeveloped ANC is a significant cause of neonatal asphyxia since mothers under irregular monitoring are more likely to develop conditions that include anemia, hypertensive disorders, and obstructed labor (13).

Obstetric complications proved to be one of the best predictors in the study, as preeclampsia, antepartum hemorrhage, lengthy rupture of membranes, and lengthy labor were all significantly related to birth asphyxia. Such associations are well-reported in previous studies. As an example, complications, like prolonged rupture of membranes and obstructed labor in Southern Ethiopia, were closely associated with neonatal asphyxia mainly because of hypoxia due to the prolonged fetal distress (14). Likewise, hypoxic ischemic encephalopathy after complex deliveries has been identified as one of the serious after-effects, with research indicating that failure to recognize and administer therapeutic hypothermia promptly exacerbates neonatal outcome (15). Addis Ababa hospital data also showed direct effects of obstetric complications on stillbirths and early neonatal death, which further demonstrated that they contribute to neonatal asphyxia (16). Psychosocial and biological risk factors were also identified in research in Colombia, as maternal stress, poor social support, and unplanned pregnancies have been related to high risk of perinatal asphyxia (17). .

Despite the fact that the research did not specifically test psychosocial determinants, maternal education proved to be a significant factor, and uneducated mothers were more likely to deliver asphyxiated babies. This observation confirms a research study in China, which found that a poor socioeconomic/educational status of mothers predisposed them to perinatal complications (18). The same patterns were highlighted in Uganda, where the delayed hospitalization and an absence of informed decision-making caused a prolonged labor and, accordingly, asphyxia (19). The low birth weight and prematurity were recognized as neonatal factors in the study. Infants with a birth weight of below 2 kilograms born preterm were almost fourfold more likely to develop birth asphyxia. Similar results were described in Bekoji Public Hospital, Ethiopia, where prematurity and low birth weight became a consistent determinant (20). A multicenter study in Nepal also reported that continuous neonatal immaturity with obstetric complications contributed greatly to the incidence of birth asphyxia and adverse outcomes (21). Such results highlight the increased susceptibility of preterm newborns who do not have sufficient physiological reserves to address intrapartum hypoxia.

The findings are most applicable in the Pakistani context, where birth asphyxia is one of the leading causes of neonatal mortality despite having tertiary care facilities. The same determinants had been reported in earlier studies in Lahore and other parts of Pakistan, which included maternal age, anemia, obstructed labor, and poor ANC use, promoting the gaps in the maternal and newborn health provision (2). Significantly, results indicate that whilst more complex medical treatments, including neonatal intensive care units, are the most important, proactive measures, including maternal health optimization and timely intrapartum monitoring, could yield the greatest decrease in the burden of neonatal asphyxia. Analysis of results with respect to international evidence indicates some startling similarities in the conditions of various geographical and health systems. Across Africa and Asia, there is a consistent finding of maternal complications, no ANC, and prematurity at birth being the most predictive factors of birth asphyxia (14). The same factors are observed in countries with more developed health systems, including China and Thailand, which indicates that although resource constraints escalate the burden, the biological and obstetric determinants are universal (11).

The current research is a contribution to the growing literature with regard to the multifactorial etiology of birth asphyxia and the importance of comprehensive maternal and neonatal care. Increasing the quality of antenatal care services, improving intrapartum surveillance through the use of a partograph, availing timely obstetric intervention, and increasing neonatal resuscitation among health providers are the necessary interventions that could reduce the risk of birth asphyxia among preterm babies. Additionally, certain interventions that will address the deficiency of maternal education and provide women with information about pregnancy and labor complications can contribute to the health-seeking behavior and reduce the number of avoidable outcomes (16). Despite the fact that the results are in line with the world literature, the study also has limitations. Some psychosocial determinants that cannot be measured and recall bias in maternal interviews also limit interpretation. However, this study is powerful as it has focused on the preterm newborn infants that are not adequately represented in the previous studies, yet they are more prone to asphyxia (18). The present study proves the statement that birth asphyxia in preterm infants is closely related to maternal age, absence of prenatal care, birth issues, and preterm deliveries.

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CONCLUSION

This case-control study carried out in the Services Institute of Medical Sciences, Lahore, shows that birth asphyxia among preterm babies is a multifactorial disorder caused by maternal, obstetric, and neonatal factors. The maternal age (over 30 years), lack of antenatal care, pregnancy-related complications (preeclampsia), antepartum bleeding, extended labor, and low infant weight were the first most important predictors. These results are in line with the international evidences, which demonstrate that despite geographical and health systems variations, the determinants of birth asphyxia are either identical or slightly different. Particularly, the results indicate the following concept: preventive interventions such as improvements in the quality of services provided during antenatal care, early identification and management of high-risk pregnancies, the use of partograph in the labor process, and the intensification of the neonatal resuscitation facilities are necessary to eliminate the frequency of asphyxia among premature infants. Certain interventions capable of reversing medical and social determinants can contribute greatly to neonatal outcomes and preventable mortalities within resource-constrained settings like Pakistan.

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