Analyzing the Predictors of Mortality Among Asphyxiated Neonates

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Birth asphyxia refers to the inability to initiate and sustain breathing at birth, leading to inadequate oxygen supply to vital organs. It is one of the most common causes of perinatal brain injury, contributing to high rates of morbidity and mortality. Neonatal asphyxia is a major cause of early neonatal death, accounting for an estimated 900,000 deaths annually. It results from impaired respiratory gas exchange in the fetus or newborn, causing hypoxia, hypercapnia, and, in some cases, ischemia. This condition can affect multiple organs, leading to biochemical and functional changes, such as lactic acidosis, which may result in death or severe neurological impairment. Neonatal asphyxia is frequently associated with multiple organ failure, primarily impacting the brain, heart, and kidneys. It can lead to complications affecting motor, sensory, cognitive, and psychological development. Several factors contribute to birth asphyxia, including maternal anemia, diabetes, and placental abruption. Other significant predictors of mortality among asphyxiated neonates include neonatal sepsis, preterm birth, lack of Kangaroo Mother Care (KMC), low birth weight, seizures, need for resuscitation at birth, stage III asphyxia, hypoxic-ischemic encephalopathy (stages II and III), seizures and thrombocytopenia. This systematic review aims to identify the pooled predictors of mortality among asphyxiated neonates. Various online databases, including PubMed, MEDLINE, Google Scholar, and WHO websites, were searched for relevant studies. The review included cross-sectional, case-control, and cohort studies conducted in Pakistan and Ethiopia. Data entry and statistical analysis were performed using Excel and SPSS (version 27). The pooled mortality rate of birth asphyxia was found to be 64.0%. Among asphyxiated neonates, 27.1% who were delivered via spontaneous vaginal delivery (SVD) did not survive. Mortality rates were 39.4% for neonates born after prolonged labor, 42.6% for those delivered following premature rupture of membranes, and 50% for those weighing less than 2500g at birth. Additionally, 60.2% of asphyxiated neonates with seizures and 35.7% requiring resuscitation at birth did not survive. The highest mortality rate (81.1%) was observed in neonates with stage III asphyxia. It is concluded that asphyxiated neonates exhibit a high mortality rate. Key predictors of mortality include neonatal sepsis, vaginal delivery, lack of Kangaroo Mother Care (KMC), low birth weight, seizures, need for resuscitation at birth, stage III asphyxia, advanced maternal age, delivery complications, and prolonged rupture of membranes.

Keywords: Mortality, Neonates, Asphyxia, Predictors

Introduction:

Birth asphyxia is defined as the failure to initiate and sustain breathing at birth. This lack of effective respiration leads to hypoxemia (oxygen deficiency) and hypercapnia (accumulation of carbon dioxide), which can cause cardiac dysfunction [1]. As one of the leading causes of neonatal mortality, birth asphyxia can result from complications occurring in the antepartum, intrapartum, or postpartum periods, or a combination of these [2]. Birth asphyxia is classified as mild, moderate, or severe based on the APGAR score at one, five, and ten minutes after birth [3]. There are various methods to identify birth asphyxia. An APGAR score of less than 7 indicates birth asphyxia, while an umbilical cord blood analysis showing excessive acidity suggests oxygen deficiency. Symptoms in affected infants include weak breathing, low pulse rate, bluish or pale skin, seizures within hours of birth, and impaired muscle tone [4]. Arterial blood gas (ABG) analysis provides crucial information on the newborn's oxygenation, ventilation, and acid-base status [5].

The neonatal period is the most critical for a child's survival, with approximately 1 million newborns dying within the first 24 hours and another 2 million within the first week of life. The highest risk of death occurs within the first 28 days [6]. Annually, around 2.4 million newborns die worldwide, with birth asphyxia responsible for approximately 23% of these deaths, predominantly in low- and middle-income countries [7]. According to the World Health Organization (WHO), neonatal asphyxia is the third leading cause of neonatal mortality, following sepsis and preterm birth, contributing to an estimated 23% (4 million) of neonatal deaths each year in developing nations [8]. The mortality rate among asphyxiated neonates rises with the severity of hypoxic-ischemic encephalopathy (HIE), with fatality rates reaching up to 50%, most of which occur within the first month of life [9]. Pakistan has one of the highest neonatal mortality rates globally. According to the Pakistan Demographic and Health Survey (PDHS) 2017–18, the neonatal mortality rate in the country is 42 per 1,000 live births [10]. Birth asphyxia accounts for approximately 25% of neonatal deaths in Pakistan [11].

Asphyxia results from impaired blood-gas exchange, leading to oxygen deficiency (hypoxemia) and accumulation of carbon dioxide (hypercapnia). Depending on the severity, oxygen deprivation can be incomplete (hypoxia) or complete (anoxia), affecting gas exchange in the placenta or lungs. Prolonged hypoxia exacerbates hypoxemia and hypercapni, leading to oxygen debt in tissues and vital organs. This triggers anaerobic glycolysis and lactic acidosis, causing further damage and potentially leading to hypoxic-ischemic encephalopathy. The duration of oxygen deprivation significantly impacts the severity of complications [12]. Birth asphyxia can have severe long-term consequences, including neonatal encephalopathy, multiple organ failure (affecting the heart, brain, and adrenal glands), and fatal outcomes or lifelong disabilities [13]. Asphyxiated neonates often experience delayed motor development from three months to two years. By 18–22 months, complications such as epilepsy (16%), blindness (14%), severe hearing impairment (6%), and disabling cerebral palsy (30%) have been observed [14].

Risk factors for neonatal mortality differ between developing and developed nations. In developing countries, inadequate prenatal care, maternal malnutrition, and unhygienic birthing conditions leading to infections are primary risks. In contrast, in developed nations, tobacco and alcohol use during pregnancy, low birth weight, prematurity, and congenital defects are major contributors [15]. Additional maternal and fetal factors include anemia, pregnancy-induced hypertension, maternal diabetes, placental abruption, low birth weight, preterm birth, abnormal fetal positioning, delivery complications, meconium-stained amniotic fluid, chorioamnionitis, and prolonged rupture of membranes [16]. Early diagnosis of birth asphyxia is crucial for effective management and prevention of associated complications. Various treatment approaches are used worldwide, but therapeutic hypothermia is the only

clinically tested neuroprotective treatment that has shown success in reducing brain injury in asphyxiated full-term newborns [11].

Research Problem:

Birth asphyxia is the failure to initiate and sustain breathing at birth. It is a leading cause of neonatal mortality. Despite improvements in the management of prenatal care, ANC follow-up strategies, and the accessibility of NICU (neonatal intensive care unit) care, neonatal asphyxia is still one of the leading causes of neonatal deaths in low- and middle-income countries. Identifying the key predictors of mortality in these neonates is crucial for improving clinical management, optimizing resource allocation, and guiding interventions to enhance survival rates. This research aims to investigate the predictors of mortality among asphyxiated neonates, with a focus on maternal and neonatal risk factors.

Research Questions:

1. How do maternal factors (e.g., age, health conditions, prenatal care) influence the mortality risk in neonates with asphyxia?
2. What role do neonatal characteristics (e.g., seizures, birth weight, sex) play in predicting mortality among asphyxiated neonates?
3. What is the predictive value of the APGAR score for mortality outcomes in neonates with asphyxia?

Research Objective:

The objectives are:

To determine the maternal predictors of mortality in asphyxiated neonates.

To determine the neonatal predictors of mortality among asphyxiated neonates.

To determine the survival rate of asphyxiated neonates.

Study Areas:

Pakistan:

Pakistan, situated in South Asia, extends from approximately **23°35'N to 37°05'N latitude** and **60°50'E to 77°05'E longitude**. It is bordered by India to the east, Afghanistan and Iran to the west, China to the north, and the Arabian Sea to the south. The country's geography encompasses diverse physiographic regions, including high mountain ranges, plateaus, arid deserts, and fertile alluvial plains, which influence its climate, ecosystems, and socio-economic activities. The study areas of the majority of articles included are from different districts of Pakistan, such as Matiari, Multan, Lahore, Bahawalpur, Peshawar, and Hyderabad.

Ethiopia:

Ethiopia, located in the Horn of Africa, lies between approximately **3°24'N to 14°53'N latitude** and **32°42'E to 48°12'E longitude**. It is bordered by Eritrea to the north, Djibouti and Somalia to the east, Kenya to the south, and Sudan and South Sudan to the west. The country's terrain is dominated by the Ethiopian Highlands, rift valleys, and lowland plains, contributing to its varied climate, biodiversity, and agricultural potential. A Few study areas are from Ethiopia, in which some regions are included, such as Oromiya, Amhara, and Southwest Ethiopia near Addis Ababa.

Methodology:

Study Designs:

All studies with cross-sectional, case-control, and cohort study designs that were conducted in Pakistan and Ethiopia were included.

Sample Size:

The extracted sample size is 378 [17], which was calculated by using Cochran's formula: Eq. (1)

$$n_0 = \frac{Z^2 pq}{e^2} \quad \text{Eq. (1)}$$

Where **n** is the sample size, **z** is the confidence interval, **p** is the standard deviation, **q** is (1-p), and **e** is the margin of error.

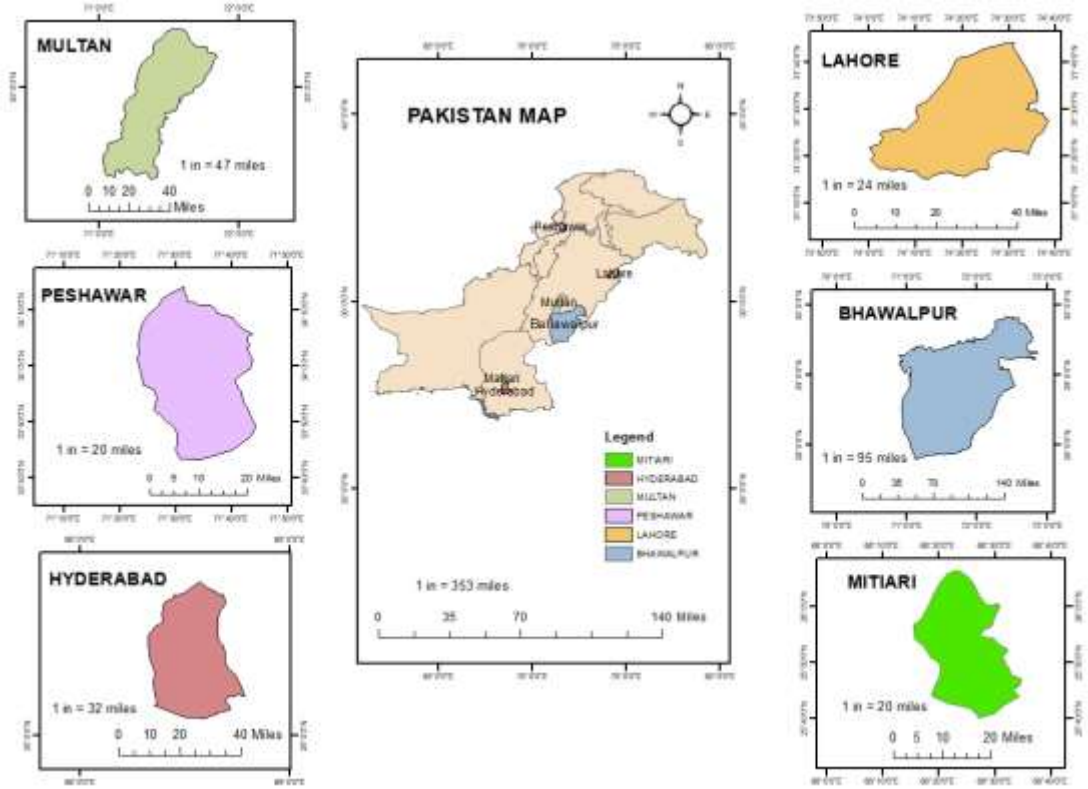

Figure 1. Study Areas of Pakistan

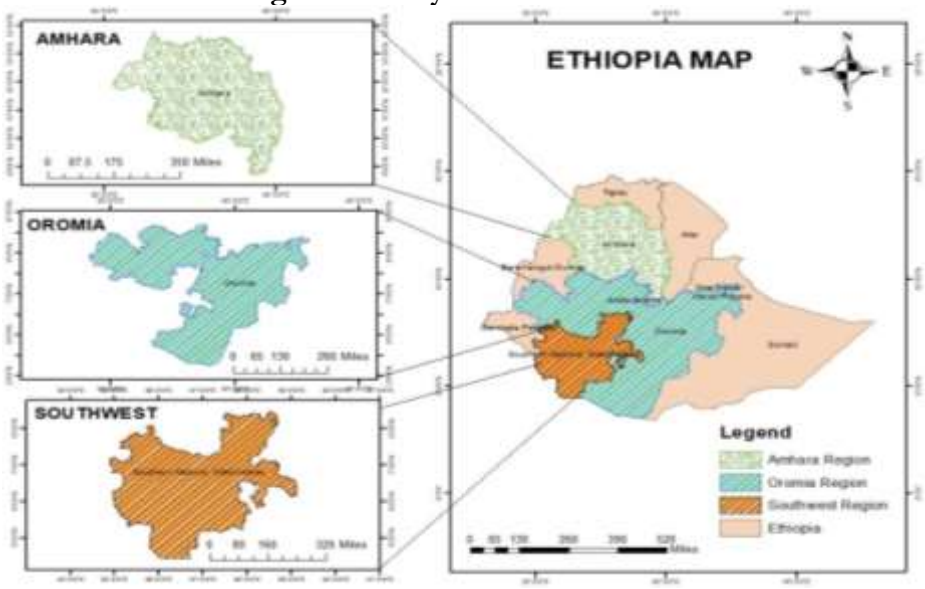

Figure 2. Study Areas of Ethiopia

Study Participants:

Asphyxiated neonates and their mothers were included and were pooled from studies.

Study Variables:

Age of mother, parity, mode of delivery, duration of labor, premature rupture of membranes, delivery complication, sex of newborn, first and fifth minute APGAR score, hypothermia, comorbidities, weight at admission, seizure, requiring resuscitation, and stage of asphyxia.

Data Collection Tools:

The data were collected using a semi-structured data extraction tool. The databases, including PubMed, MEDLINE and other relevant sources, including the Google search engine, Google Scholar, and World Health Organization websites, were used to search for relevant articles.

Data Analysis:

Descriptive quantitative analysis was done by using Excel and SPSS software with version 27.

Categorical data were presented as frequencies and percentages.

Pie charts and frequency tables were used to visualize the data.

Suitable statistical tools and the chi-square test were applied for data analysis.

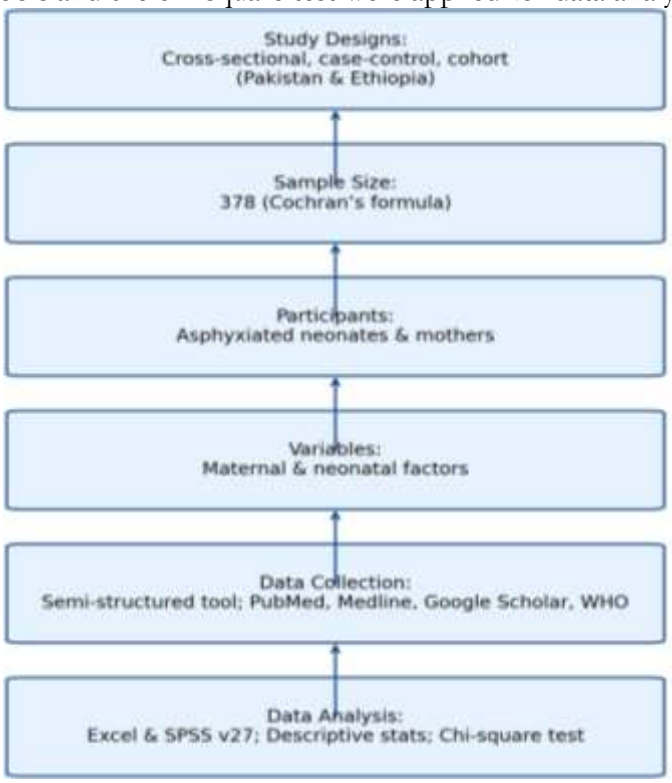

Fig 3. Flowchart of Methodology

Results And Analysis:

Table 02. Sociodemographic Characteristics of Study Subjects

VARIABLE	CATEGORY	FREQUENCY (N)	PERCENT %
Age of the mother	<25 years	126	33.3
	25-34 years	219	57.9
	>35 years	33	8.7
Residence	Urban	158	41.8
	Rural	220	58.2
Sex of the newborn	Male	232	61.4
	Female	146	38.6
Age of the newborn at admission	>1 hr	106	28
	1-24 hr	240	63.5
	>24 hr	32	8.5

Table 01. Characteristics of included studies in the systematic review of the pooled predictors of mortality among asphyxiated neonates

PRIMARY AUTHOR AND YEAR	STUDY AREA	STUDY DESIGN	SAMPLE SIZE	STUDY SPECIFIC FACTORS	ANALYSIS AND FINDINGS
Nadeem et al 2021	Pakistan	Case-control	426	Meconium-stained liquor, prolonged labour, fetal distress, parity, neonatal mortality	Data were analyzed by SPSS 26. Meconium-stained liquor is a major predictor of birth asphyxia
Amin et al, 2017	Pakistan	Case-control	124	Mortality rate, birth weight, gestational age, pregnancy complications	Data was analyzed by SPSS version 10. Allopurinol treatment reduces the neonatal mortality rate
Hassan et al 2021	Pakistan	Case-control	308	IUGR, breech presentation, mortality, GDM, birth weight, fetal distress	Data were analyzed by SPSS 24. Chi-square test applied. Mortality can be reduced by reducing the risk factors of asphyxia.
Younus et al, 2020	Pakistan	Descriptive Cross-sectional	384	Neonatal mortality, gender, Age at presentation, weight of child, co-morbidities	Data were analyzed by SPSS 20. Chi-square test applied. Metabolic acidosis adversely affects asphyxiated neonates.
Samad et al 2016	Pakistan	Prospective Cohort	100	Mode of delivery, mortality rate, presentation other than cephalic, fever at time of delivery	Data were analyzed by a paired sample t-test by SPSS software. Alteration in electrolytes leads to damage to the vital organs of neonates.
Siddiqui et al 2021	Pakistan	Descriptive Case Series	150	Neonatal mortality, neurological complications, mode of delivery, gestational age	Data were analyzed in SPSS version 23. Birth asphyxia has a significant association with neonatal mortality
Tabassum et al, 2014	Pakistan	Case-control	246	Pregnancy complications, cyanosis, labor type, neonatal mortality, size of baby at birth	Data were analyzed by STATA (version 12). Neonatal and late fetal deaths are closely linked to maternal deaths
Daka et al, 2023	Ethiopia	Retrospective Cohort	655	Incidence rate of death, APGAR score, stage of HIE, cry at birth	The data were analyzed in STATA Version 14. High neonatal mortality rate requires proper intervention regarding PROM, APGAR

Kebede et al, 2024	Ethiopia	Prospective Cohort	153	Gender of neonate, Newborn weight, APGAR score, KMC utilization, Co-morbidities, mortality, Pregnancy complications	The data were analyzed in STATA (V.16). Asphyxiated neonates had a higher incidence of mortality, with a median survival time of only 8 days.
Yitayew et al 2022	Ethiopia	Retrospective Cohort	378	PROM seizure neonatal mortality APGAR score stage of asphyxia requiring resuscitation	The data were analyzed in STATA Version 16. admission weight, seizures were significant predictors of mortality
Atta et al, 2024	Pakistan	Cross-sectional	105	Gestational age, birth weight, gender, pre-eclampsia, and acute kidney injury	Statistical software (IBM SPSS 26) was used to analyze the data. Frequency of acute kidney injury is not associated with birth asphyxia, mode of delivery, gestational age, pre-eclampsia, or birth weight.
Dhiloo et al 2024	Pakistan	Cross-sectional	118	118	Previous history of birth asphyxia, parity, comorbidities, prevalence of birth asphyxia
Haris et al 2024	Pakistan	Descriptive Cross-sectional	163	163	Gestational age, birth weight, APGAR score at 1 min, APGAR score at 5 mins, blood gases
Memon et al, 2021	Pakistan	Cross-sectional	120	120	Gender gestational age maternal age Mode of delivery acute kidney injury
Noor et al, 2020	Pakistan	Descriptive Cross-sectional	153	153	Gender, birth asphyxia, estational age, Early intervention
Ketema et al 2023	Ethiopia	Prospective cohort	480	480	Birth type pregnancy-related Complication parity mode of delivery APGAR score
Bekele et al, 2024	Ethiopia	Retrospective cohort study	760	760	Birth weight, respiratory distress syndrome, meconium aspiration syndrome, neonatal sepsis
Solbana et al, 2025	Ethiopia	Retrospective cohort	373	373	Neonatal convulsion, cord prolapse, pregnancy-induced hypertension, maternal iron deficiency anemia, birth weight

Wudu et al, 2025	Ethiopia	Retrospective	10	10	Pregnancy complications, labor complications, hypoxic-ischemic encephalopathy, neonatal seizures
Tegegne et al, 2024	Ethiopia	Retrospective	330	330	Maternal age, gravidity, altered consciousness, depressed moro reflex

Table 3. Reproductive Health-Related Characteristics of the mother

VARIABLES	CATEGORY	FREQUENCY (N)	PERCENT %
ANC visit	Yes	350	92.6
	No	28	7.4
Obstetric Complications	Yes	30	7.9
	No	348	92.1
Parity	Primigravida	226	59.8
	Multigravida	152	40.2
Mode of Delivery	SVD	243	64.3
	Assisted VD	67	17.7
	C/S	68	18
Duration of Labor	Prolonged	137	36.2
	Normal	241	63.8
Was there a PROM	Yes	47	12.4
	No	331	87.6
Delivery Complication	Yes	126	33.3
	No	252	66.7
Multiple Birth	Yes	8	2.1
	No	370	97.9

The sociodemographic distribution of the study subjects is shown in Table 02. The majority of mothers (57.9%) were in the age group 25–34 years, followed by 33.3% who were younger than 25 years, and only 8.7% were aged above 35 years. More than half of the mothers (58.2%) resided in rural areas, whereas 41.8% lived in urban settings. Among the newborns, males predominated, comprising 61.4% of the sample, while females accounted for 38.6%. Regarding the age of the neonate at admission, most were admitted between 1–24 hours after birth (63.5%), while 28% were admitted within the first hour, and only 8.5% were admitted after 24 hours. These findings indicate that most neonates were presented to healthcare facilities early, within the first day of life, which is a critical period for neonatal resuscitation and management.

Table 03 describes reproductive and obstetric characteristics. A large proportion of mothers (92.6%) attended at least one antenatal care (ANC) visit during pregnancy, with only 7.4% reporting no ANC attendance. Obstetric complications were infrequent, reported by just 7.9% of mothers, while 92.1% had no such complications. Parity analysis showed that 59.8% were primigravida, and 40.2% were multigravida. Most deliveries (64.3%) were spontaneous vaginal deliveries (SVD), followed by 18% Cesarean sections and 17.7% assisted vaginal deliveries. Duration of labor was normal in 63.8% of cases, while 36.2% experienced prolonged labor. Premature rupture of membranes (PROM) was observed in 12.4% of deliveries. Delivery complications occurred in 33.3% of cases, whereas 66.7% had no complications. Multiple births were rare (2.1%), with the overwhelming majority (97.9%) being singleton deliveries. These data reflect relatively favorable maternal health indicators, with high ANC coverage, a predominance of SVD, and generally low rates of obstetric complications.

Table 04. Newborn Health-Related Characteristics of the Study Subjects

VARIABLES	CATEGORIES	FREQUENCY (N)	PERCENT (%)
Weight at Admission	<2500 g	54	14.3
	>2500 g	324	85.7
Gestational Age	Preterm	17	4.5
	Term	324	85.7
	Unknown	37	9.8
First-minute APGAR score	<3 score	61	16.1
	4-5 score	207	54.8
	6-7 score	85	22.5
	8-10 score	2	0.5
	Unknown	23	6.1
Fifth-minute APGAR score	<3 score	8	2.1
	4-5 score	120	31.7
	6-7 score	178	47.1
	8-10 score	42	11.1
	Unknown	30	7.9
Required Resuscitation	Yes	300	79.4
	No	78	20.6
Hypothermia	Yes	262	69.3
	No	116	30.7
Comorbidity	Yes	293	77.5
	No	85	22.5
Stage of Asphyxia	Mild	90	23.8
	Moderate	235	62.2
	Severe	53	14

Was the Seizure	Yes	93	24.6
	No	285	75.4

The neonatal health profile is summarized in Table 04. At the time of admission, the majority of neonates (85.7%) had a birth weight above 2500 g, while 14.3% were of low birth weight (<2500 g). Most were born at term (85.7%), with preterm births accounting for only 4.5%, and gestational age unknown in 9.8% of cases. APGAR scores at the first minute revealed that more than half of the neonates (54.8%) scored 4–5, suggesting moderate birth distress. An additional 22.5% scored 6–7, while 16.1% scored <3, indicating severe asphyxia. Only 0.5% achieved scores between 8–10, and 6.1% had missing data. By the fifth minute, APGAR scores showed improvement: 47.1% scored 6–7, 31.7% scored 4–5, 11.1% scored 8–10, and 2.1% remained <3, while 7.9% were unknown. Resuscitation was required in 79.4% of neonates, highlighting the high burden of birth asphyxia. Hypothermia was present in 69.3% of cases. Comorbidities, such as infections or metabolic disturbances, were recorded in 77.5% of neonates. Regarding the severity of asphyxia, 62.2% were classified as stage 2 (moderate), 23.8% as stage 1 (mild), and 14% as stage 3 (severe). Seizures occurred in 24.6% of neonates, reflecting significant neurological involvement.

Table 05. Predictors of Mortality among Asphyxiated Neonates

VARIABLES	CATEGORY	SURVIVAL STATUS OF ASPHYXIATED NEONATES		P-value
		CENSORED	DIED	
Age of Mother	<25 years	87 (69%)	39 (31%)	0.715
	25-34 years	143 (65.9%)	76 (34.1%)	0.306
	>35 years	27 (81.8%)	6 (18.2%)	
Residence	Urban	120 (75.9%)	38 (24.1%)	
	Rural	137 (62.3%)	83 (37.7%)	0.064
Parity	Primigravida	146 (64.6%)	80 (35.4%)	
	Multigravida	111 (73%)	41 (27%)	
Mode of Delivery	SVD	178 (40%)	65 (27.1%)	
	Assisted VD	39 (8.3%)	28 (11%)	0.826
	C/S	40 (2.4%)	28 (2.3%)	0.99
Duration of Labor	Prolonged	83 (60.6%)	54 (39.4%)	0.97
	Normal	174 (72.2%)	67 (27.8%)	
Is there PROM	Yes	27 (57.4%)	20 (42.6%)	0.071
	No	230 (69.5%)	101 (30.5%)	
Was there a delivery complication	Yes	76 (60.3%)	50 (39.7%)	0.39
	No	181 (70.8%)	71 (28.2%)	
Weight at Admission	<2500 g	27 (50%)	27 (50%)	0.02
	>2500 g	230 (71%)	94 (29%)	
Was there a Seizure	Yes	37 (39.8%)	56 (60.2%)	0.038
	No	220 (71.2%)	65 (22.8%)	
Requiring resuscitation	Yes	193 (64.3%)	107 (35.7%)	0.012
	No	64 (82.1%)	14 (17.9%)	
Stage of Asphyxia	Stage 1	84 (93.3%)	6 (6.7%)	
	Stage 2	163 (69.4%)	72 (30.6%)	0.003
	Stage 3	10 (18.9%)	43 (81.1%)	<0.001

Table 05 presents the bivariate analysis of maternal and neonatal factors associated with mortality in asphyxiated neonates.

Maternal Characteristics:

Maternal age was not significantly associated with mortality ($p > 0.05$). Mortality rates were slightly higher among younger mothers (<25 years: 31.0%) and those aged 25–34 years (34.1%) compared to older mothers (>35 years: 18.2%), but the differences were not statistically significant. Residence showed a borderline association ($p = 0.064$), with higher mortality in rural areas (37.7%) compared to urban areas (24.1%). Parity was not significantly related to mortality, although primigravida mothers had a higher neonatal mortality rate (35.4%) than multigravida mothers (27.0%).

Delivery Characteristics:

Mode of delivery, duration of labor, PROM, and delivery complications did not show statistically significant associations with mortality. However, PROM approached significance ($p = 0.071$), with affected neonates experiencing a higher mortality rate (42.6%) compared to those without PROM (30.5%).

Neonatal Characteristics:

Several neonatal variables were significantly associated with mortality:

Birth weight: Low birth weight (<2500 g) was a significant predictor ($p = 0.02$). Half of these neonates died (50%) compared to 29% of those with normal birth weight.

Seizures: The presence of seizures was strongly associated with mortality ($p = 0.038$), with affected neonates having a mortality rate of 60.2% compared to 22.8% in those without seizures.

Resuscitation requirement: Neonates who required resuscitation had a higher mortality rate (35.7%) than those who did not (17.9%), and this association was statistically significant ($p = 0.012$).

Stage of asphyxia: Severity of asphyxia was a highly significant predictor. Mortality was lowest in stage 1 (6.7%), increased in stage 2 (30.6%, $p = 0.003$), and was extremely high in stage 3 (81.1%, $p < 0.001$).

Figure 04 shows that 64% of asphyxiated neonates died during the study period, while only 36% survived. This finding clearly demonstrates the substantial burden of mortality associated with birth asphyxia in this population.

The study population was characterized by mothers who generally had good ANC coverage and a predominance of normal delivery patterns, yet the neonatal outcomes revealed substantial morbidity and mortality. Low birth weight, seizures, need for resuscitation, and higher stages of asphyxia were identified as significant predictors of mortality. Although maternal and obstetric factors such as age, parity, and delivery complications were not statistically significant predictors in this study, rural residence and PROM showed borderline associations with higher mortality. The findings emphasize the need for targeted interventions focusing on early detection and management of high-risk neonates, particularly those with low birth weight, seizures, or severe asphyxia, as well as the strengthening of perinatal care services in rural areas.

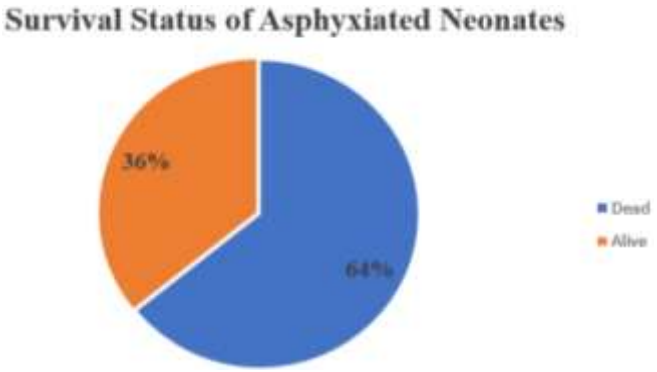

Figure 04. Percentage distribution of survival status of asphyxiated neonates

Discussion:

Neonatal mortality remains alarmingly high worldwide, with Pakistan among the countries experiencing the highest neonatal mortality rate (NMR). Birth asphyxia accounts for approximately 25% of neonatal deaths in Pakistan [10]. A study by [18] found that neonates requiring resuscitation had a 2.11 times higher risk of mortality than those who did not. Newborns needing immediate resuscitation after birth often suffer from hypoxia, respiratory distress, and metabolic acidosis. Additionally, ineffective resuscitation techniques can lead to poor clinical outcomes. This systematic review also identifies the failure to establish spontaneous breathing at birth as a significant risk factor for neonatal mortality due to asphyxia. Interestingly, female neonates had a lower risk of mortality compared to males, potentially because male newborns are more susceptible to birth asphyxia and its associated cardiovascular and respiratory complications [19].

Birth asphyxia is more prevalent among neonates born to mothers aged 18 to 35. A study from Aga Khan University found a significant correlation between maternal age and birth asphyxia [2]. Other key predictors of mortality in asphyxiated neonates include the absence of Kangaroo Mother Care (KMC) and vaginal delivery. Neonates who received KMC had a lower risk of mortality, likely due to improved stabilization and early breastfeeding initiation, reducing the chances of hypoglycemia and subsequent complications. Additionally, neonates delivered via Cesarean section had a lower risk of death compared to those born vaginally. These findings underscore the importance of timely obstetric interventions and effective neonatal resuscitation [13].

Primigravida mothers had a 1.75 times higher likelihood of giving birth to an asphyxiated neonate [4]. Severe asphyxia, indicated by an APGAR score below 3 at the fifth minute, increases neonatal mortality risk by threefold due to impaired blood flow and oxygen exchange before, during, or after delivery. The APGAR score, a key measure of a newborn's condition at birth, can be influenced by gestational age, maternal medications, resuscitation efforts, and neonatal cardiac, respiratory, or neurological conditions. Severe asphyxia during the critical first and fifth minutes of life leads to oxygen deprivation in vital organs, triggering anaerobic metabolism, lactic acidosis, and, ultimately, mortality [16].

A study by Samad, Farooq et al. 2016) identified low birth weight (<2500 grams) as a major predictor of mortality among asphyxiated neonates. Preterm and low birth weight neonates are often born with insufficient surfactant levels, making them prone to breathing difficulties, cardiopulmonary instability, and birth asphyxia. Another study [20] further supports the link between prematurity, low birth weight, and reduced survival rates. Such neonates often face immune deficiencies, feeding difficulties, and impaired respiratory and thermoregulation functions, which worsen their prognosis if they do not receive specialized NICU care. Additionally, neonates experiencing seizures had a 1.52 times higher risk of death, as convulsions can cause prolonged interruptions in breathing, leading to severe oxygen deprivation. Seizures indicate substantial brain injury caused by insufficient oxygen supply and often lead to severe hypoxic-ischemic damage, increasing the risk of mortality and developmental complications. [18].

Neonates born to mothers with a history of premature rupture of membranes (PROM) during their current pregnancy faced a 1.41 times higher risk of mortality [21]. Similarly, birth asphyxia was more fatal among neonates delivered by mothers with pregnancy complications. Pregnancy-related hypertension, including conditions like preeclampsia, can elevate the risk of birth asphyxia. High blood pressure may restrict blood flow to the placenta, limiting the oxygen and nutrient supply to the fetus. This can cause fetal distress and raise the chances of complications, such as birth asphyxia, during delivery, as these findings are in line with research done by [7]. Proper antenatal care (ANC) is crucial in reducing neonatal mortality linked to birth asphyxia. This study found that neonates of mothers who did not receive ANC had a

higher risk of mortality, as ANC plays a vital role in early disease detection, pregnancy management, and fetal health monitoring [20].

Limitations and Strengths:

This review has certain limitations. First, it did not consider all possible variables from the selected studies, which might have identified additional predictors of neonatal mortality. Second, since this study relies on secondary data, its accuracy and reliability are limited, and it cannot generate new findings beyond existing research. Third, the inclusion of studies with varying methodologies in the systematic review introduces heterogeneity, which may influence the results because differences in study designs, populations, or methodologies can make it difficult to compare and synthesize findings.

Despite these limitations, this study has several strengths. The selection of literature was carefully curated to minimize publication bias and enhance result reliability. Additionally, an extensive search strategy was employed, utilizing multiple reputable databases and search engines. By combining data from multiple studies, this systematic review provides a higher level of evidence than individual studies, contributing valuable insights into neonatal mortality and birth asphyxia. This review provides reliable evidence for policymakers, clinicians, and researchers to make informed decisions.

Conclusion:

It is concluded that the asphyxiated neonates have a high incidence of mortality. The predictors of mortality among asphyxiated neonates are neonatal sepsis, vaginal delivery, not receiving kangaroo Mother Care (KMC), low admission weight, seizures, requiring resuscitation at birth, stage III of asphyxia, advanced maternal age, delivery complications, and prolonged rupture of membranes. Early identification of these risk factors can aid in timely interventions, targeted management strategies, and improved neonatal intensive care protocols to reduce mortality rates. Strengthening perinatal care, improving delivery room resuscitation, and ensuring adequate postnatal support are essential steps in mitigating the risk of mortality in asphyxiated neonates.

Recommendations:

To decrease the mortality rate among asphyxiated neonates, we recommend:

Preventing the newborns from neonatal sepsis because these neonates already have compromised organ function and weakened immunity.

Delivering the asphyxiated neonates via Cesarean section because early prevention from prolonged oxygen deprivation and birth trauma is crucial.

Provide Kangaroo Mother Care (KMC) to asphyxiated neonates because it improves oxygenation, reduces hypoxia, and provides neuroprotection.

Introducing advanced clinical practices and providing advanced diagnostic tools in low-resource settings.

Providimg multidisciplinary management by collaboration between neonatologists, neurologists, and intensivists for comprehensive care.

Giving special attention to asphyxiated neonates with low admission weight and those who have had a seizure.

Future researchers should conduct an interventional study to address further significant predictors of mortality in asphyxiated neonates.

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