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Perinatal Asphyxia and Associated Factors among Neonates Admitted at Neonatal Intensive Care Unit of Dessie Comprehensive Specialized Hospital, North-East Ethiopia: A Retrospective Cross-Sectional Study

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Abstract

Background: Perinatal asphyxia is a critical clinical condition that contributes significantly to infant morbidity and mortality. Each year, one-fourth of newborn deaths worldwide are linked to birth asphyxia, and Ethiopia is no exception. At the Dessie Comprehensive Specialized Hospital in north-east Ethiopia, the researchers investigated the prevalence of perinatal asphyxia and the risk factors associated with it in newborns.

Methods: A cross-sectional study design with retrospective document review was conducted. The single population proportion formula was used to calculate sample size. The participants were selected using a systematic random sampling method. Data were collected using a checklist, entered into Epi-Info™ - 7, cleaned, and then analyzed using SPSS version 23. The relationship between the dependent and independent variables was determined using odds ratios with a p-value <0.05 and a 95% CI.

Results: Out of 256 neonates, with a response rate of 97.34%, 51 (19.9%) had perinatal asphyxia. Twenty-eight (54.9%) were males; 84.3% were of normal birth weight; 72.5% were born naturally; and 94.1% were cephalic. Thirty (58.8%) had stage-I hypoxic-ischemic encephalopathy, 70.6% were discharged with improvement, and 10 (19.6%) died, giving a case fatality rate of 19.6%. Prolonged duration of labor (AOR: 18.75, 95% CI: 8.1-43.4) and delivery at a hospital (AOR: 2.55, 95% CI: 1.35-4.82) were significantly associated with perinatal asphyxia.

Conclusion: Prolonged labor and place of delivery were the most important factors influencing the occurrence of perinatal asphyxia, indicating the importance of adequate prenatal, antenatal, intrapartum, and neonatal care services.

Keywords: Perinatal; Asphyxia; Factor; Neonates; Ethiopia

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Introduction

Globally, around 4 million of the 130 million newborn infants born each year die in the neonatal period. Indeed, newborn deaths now account for more than 40% of all mortality among children under the age of five [1]. Three-quarters of newborn deaths occur in the first week, with the first day of life having the highest risk of death. Almost all newborn deaths (99%) occur in low- and middle-income nations, while much epidemiological and other research focuses on the one percent of deaths that occur in high-income countries. South-Central Asian countries had the largest numbers of newborn mortality, whereas Sub-Saharan Africa has the highest rates [2]. Infant mortality rates are highest (11.06%) and lowest (0.18%) in Afghanistan and Monaco, respectively; 4.96% in Ethiopia [3].

Preterm birth (28%), serious infections (26%), and asphyxia (23%) are the leading direct causes [2]. Birth asphyxia is responsible for around a quarter of all newborn deaths worldwide [4,5]. It

is the fifth leading cause of under-five mortality [6]. It kills 840,000 newborns worldwide, accounting for 23% of all neonatal deaths [7]. It is the failure to establish breathing at birth [8]. Perinatal Asphyxia (PNA) is a lack of blood flow or gas exchange to or from the fetus before, during, or after birth [9]. It causes hypoxia, hypercapnia, metabolic acidosis, and multiorgan failure [10], with the brain being the most vulnerable organ. Other major organ systems that have been harmed include the heart, kidneys, lungs, and liver [11]. PNA is also known as Hypoxic-Ischemic Encephalopathy (HIE), which is defined by clinical and biochemical evidence of acute or subacute brain injury caused by hypoxia. The basic causes of this condition are systemic hypoxia and/or decreased Cerebral Blood Flow (CBF) [7].

In East and Central Africa, the combined prevalence of PNA was 9.1% and 18.0%, respectively [12]. Ethiopia, on the other hand, has the highest combined prevalence (19.3%) of PNA [8]. It ranks fourth among the top ten countries with the highest number of neonatal mortalities in 2019 [13]. A significant number of neonates with PNA have died [14], with a case fatality rate of 37.5% [15]. However, the third Sustainable Development Goal (SDG) is aimed to end neonatal mortality [16]. If effective health measures are delivered before birth and during the first week of life, up to two-thirds of neonatal fatalities can be averted [17]. The early detection of risk factors during pregnancy, as well as the right provision of intervention, are essential for preventing PNA and its complications [18]. With this study, the proportion of neonates admitted to the Dessie Comprehensive Specialized Hospital's (DCSH's) Neonatal Intensive Care Unit (NICU) with PNA and associated risk factors were investigated.

Materials and Methods

Ethics approval

The study was approved by the Department of Public Health of Wollo University's College of Medicine and Health Sciences (Ref. No: PH/862/2011). Because the study was a retrospective document review, waived informed consent was obtained from DCSH. The information collected was kept confidential. We also followed the "World Medical Association Declaration of Helsinki: Ethical guidelines for medical research involving human patients" [19].

Design and setting

From September to April 2019, a facility-based cross-sectional study was undertaken at DCSH's NICU in Dessie City Administration (DCA), North-East Ethiopia. Dessie is located 401 kilometers north of Ethiopia's capital, Addis Ababa, and 480 kilometers southeast of Bahir Dar, the capital of the Amhara regional state [19]. It is Ethiopia's largest metropolis and urban center in the North-East [20]. DCSH is North-East Ethiopia's largest and most advanced tertiary hospital. In this area, it has a large catchment area [20]. More than eight million people have been benefiting from it [20,21].

Participants and sample

All newborns admitted to DCSH's NICU served as the source population, whereas all neonates admitted and registered at DCSH's NICU from September to April 2019 served as the study population. All neonates who were registered and had complete chart information were included. The sample size was calculated using a single population proportion formula with a 95 percent confidence interval and a 5% margin of error, by extrapolating the proportion of PA (22%) from a previous study conducted in similar location and institution as follows [22]: $n = [Z (\alpha/2)^2 p(1-P)]/d^2$, where *n* is the initial sample size, *Z* is the standard normal value (1.96) at 95% CI, *P* is the prevalence of PNA (0.22), and d is the maximum margin of error that may be accepted (0.05). As a result, the sample size was determined to be 263 [$n = (1.96)^2(0.22) \times (0.78)/(0.05)^2$]. Then, among a total of 1,375 newborns, those who had completed data were picked using the registration book as a sampling frame (1 to N). The samples were selected using systematic random sampling in every 5th value (K=1375/256 = 5.37); the 3rd document being chosen as the first value, using lottery method.

Data collection procedures

Retrospective document reviews were carried out using checklists that had been prepared ahead of time. After receiving a half-day training on the study, two experienced BSc nurses collected the data. Every checklist was verified on a daily basis for clarity and completeness.

Data processing and analysis

The data were entered into Epi-Info™ 7 and cleaned. Then imported into SPSS version 23.0 for analysis. Frequency tables, charts, and graphs were used to provide descriptive statistics such as mode, median, mean, standard deviation, range, and variance. OR was used to determine the strength of the association between the dependent and independent variables. Statistical significance was calculated with a p-Value <0.05 at 95% CI.

Data quality control

The checklist questionnaire's reliability and validity have been pre-tested in a related setting (Boru Meda Hospital), and necessary adjustments have been made. Daily checks were made to ensure that each checklist was clear and complete.

Results

Sociodemographic characteristics

With missing and partial charts substituted, the response rate was 97.34%. The study comprised a total of 256 neonates, with 58.6% of them being males. 65.6% were admitted within the first 24 h of life. Most of them (71.5%) were delivered in DCSH (Table 1).

Proportion of perinatal asphyxia

From 256 neonates, 19.92% were diagnosed with birth asphyxia at the 5th minute after delivery, with an APGAR score of 5, of whom 54.9% were males, 88.2% were singleton, 84.3% had normal birth weight, and 78.4% stayed for 24 h to 7 days. 51% of the asphyxiated neonates had an APGAR score of 4 in the 1st minute, while 70.6% had an APGAR score of 4 to 7 at the 5th minute. The majority of neonates (78.4%) were unable to cry. Most of the asphyxiated neonates were born to primiparous women (ages 21 to 25), using assisted vaginal delivery (Table 2).

About 19.6% of the mothers of the asphyxiated neonates had documented pregnancy problems, such as antepartum hemorrhage (7.8%), preeclampsia (3.9%), anemia (3.9%), hypertension (2%), and overt diabetes mellitus (2%) (Figure 1).

Approximately 74.5% of all asphyxiated neonates experienced intrapartum problems (Figure 2).

Stages I, II, and III HIE were identified in 30 (58.8%), 18 (35.3%), and 3 (5.9%) of all asphyxiated newborns, respectively (Figure 3).

Thirty-six (70.6%) asphyxiated neonates were discharged with some improvement, while ten of them (19.6%) died, resulting in a case fatality rate of 19.91% (Figure 4).

Table 1: Sociodemographic characteristics of neonates admitted at NICU in DCSH, North-East Ethiopia (n=256), April 2019.

Variable		Category	Frequency	Percentage
Sex of neonate		Male	150	58.6
		Female	106	41.4
		Total	256	100
Age of mother in years		15-20	13	5.1
		21-25	88	34.4
		26-30	124	48.4
		30-35	27	10.5
		36-40	4	1.6
Age at admission		<24 h	168	65.6
		24 h -14 days	83	32.4
		>14 days	5	2
		Total	256	100
Birth order		Single	242	94.5
		Twin	13	5.1
		Triplet and more	1	0.4
		Total	256	100
Place of delivery		DRH	183	71.5
		Other health facility	73	28.5
		Total	256	100
Birth Weight (in gm)		<2500	35	13.7
		2500-4000	214	83.6
		>4000	7	2.7
		Total	256	100
GA at birth (in week)		<37	15	5.9
		37-42	232	90.6
		>42	9	3.5
		Total	256	100
Mode of delivery		Spontaneous Vaginal Delivery (SVD)	242	94.5
		Assisted vaginal	9	3.5
		Cesarean Section (CS)	5	2
APGAR score	At 1st Minute	<4	26	10.2
		(4-7)	73	28.5
		≥ 7	157	61.3
		Total	256	100
	At 5th Minute	<4	15	5.9
		(4-7)	36	14.1
		≥ 7	205	80.1
		Total	256	100

Table 2: Proportion of perinatal asphyxia by variables at NICU in DCSH, North-East Ethiopia (n=51), April 2019.

Variable		Category	Frequency	Percentage
Sex of neonate		Male	28	54.9
		Female	23	45.1
		Total	51	100
Weight (gram)		<2500	7	13.7
		2500-4000	43	84.3
		>4000	1	2
		Total	51	100
Birth order		Singleton	45	88.2
		Twin	6	11.8
Duration of hospitalization		<24 h	2	3.9
		24 h -7 days	40	78.4
		>7 day	9	17.6
		Total	51	100
Clinical feature		Convulsion	12	23.5
		Unable to cry	40	78.4
		Depressed Neonatal Reflexes	7	13.7
		Hypotonia/floppiness	1	2.0
		Lethargy	10	19.6
		LOC	1	2.0
Parity		1 (Primiparous)	31	60.8
		2-4 (Multiparous)	19	37.3
		≥ 5 (Grand multiparous)	1	0.4
Presentation		Cephalic	49	96.1
		Breech	2	3.9
Age of mother in years		15-20	6	11.8
		21-25	25	49
		26-30	15	29.4
		30-35	3	5.9
		36-40	2	3.9
Mode of delivery		SVD	37	72.5
		Assisted vaginal delivery	9	17.6
		CS	5	9.8
		Total	51	100
APGAR score	At 1st minute	<4	26	51
		4-7	25	49
	At 5th minute	<4	15	29.4
		4-7	36	70.6

Factors associated with perinatal asphyxia

At both the bivariate and multivariate levels of analysis, the association between various variables and perinatal asphyxia was explored. The multivariate analysis included variables that were significant in the bivariate analysis (p-value <0.25). Place of delivery (COR=2.55; 95% CI: 1.35-4.82), and labor length (COR=18.75; 95% CI: 8.1-43.42) were significant variables in bivariate regression. Controlling for other factors, neonates born to mothers who had a lengthy labor of more than 18 h were 18.5 times more likely to develop PNA (AOR=18.5; 95% CI: 7.86, 43.69). The newborns at DCSH were 2.5 times more likely than those born in other health systems to have PNA (AOR=2.5; 95% CI: 1.18, 5.23) (Table 3).

Discussion

The vast majority of newborn deaths take place in low- and middle-income countries. Sub-Saharan Africa had the highest neonatal mortality rate in 2019 at 27 deaths per 1,000 live births, followed by Central and Southern Asia with 24 deaths per 1,000 live births. A child born in sub-Saharan Africa is 10 times more likely to

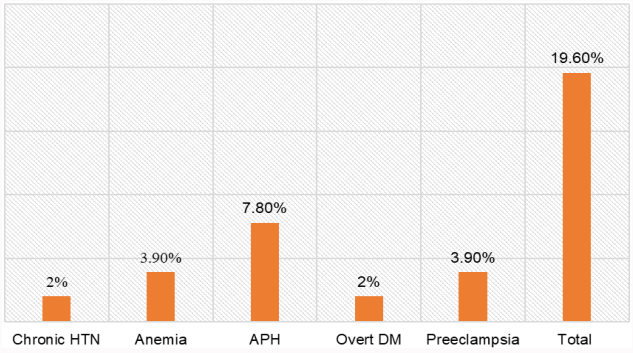

Figure 1: Proportion of documented pregnancy disorder among mothers of asphyxiated neonates at NICU in DCSH, North-East Ethiopia (n=51), April 2019.

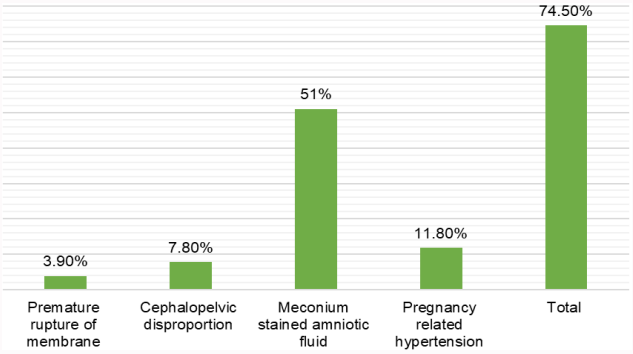

Figure 2: Proportion of intrapartum disorders of mothers among asphyxiated neonates at NICU in DCSH, North-East Ethiopia (n=51), April 2019.

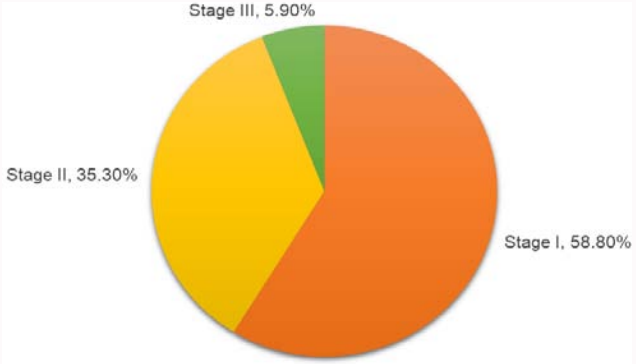

Figure 3: SARNAT stage of PNA among asphyxiated neonates at NICU in DCSH, North-East Ethiopia (n=51), April 2019.

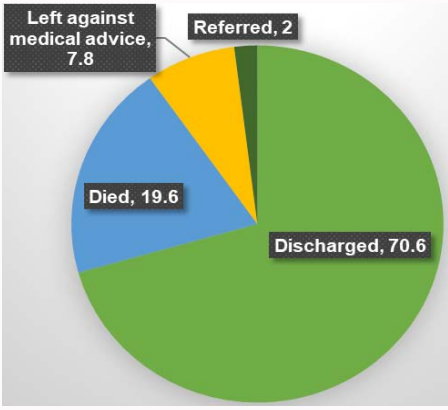

Figure 4: Outcome of asphyxiated neonates at NICU in DCSH, North-East Ethiopia (n=51), April 2019.

die in the first month than a child born in a high-income country [13], with Ethiopia not being an exception.

This study showed that the proportion of PNA was 19.9%, which was consistent with a study conducted at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia (19.8%) [23]. It was higher than the prevalence of PNA found in a study conducted in north central Ethiopia [24], where the prevalence was found to be 11.11%. However, it was lower than other studies carried out in other regions of Ethiopia, Tigray (22.1%) [22] and Jimma (32.9%) [25]. It was also slightly lower than the national pooled prevalence [26], which was 22.8%. The discrepancy could be due to the difference in care provided during the antenatal, natal, or postnatal periods, or to the sociodemographic differences between the localities, or to the time at which the studies were conducted.

The male to female ratio in this study was 1.22 to 1, which was similar to a study conducted in India [22], which was 1:1.1 [27], but much lower than a study in north central Ethiopia [24] and Nigeria [28], where male newborns were 5.02 and 2 times more likely than female newborns to asphyxiate, respectively. This difference could be due to differences in time, area of the study, and registration of neonatal data.

The majority of asphyxiated neonates (49%) were born to primiparous women, which was slightly lower than the 53.3% and 53.2% reported in studies conducted in India [29] and Nigeria [30], respectively. The figure in this study was also much lower than a study conducted in public hospitals in Tigray, Ethiopia [31], where the risk of birth asphyxia among neonates born of primiparous mothers was 5.5 times higher. The majority (30, or 60.8%) of asphyxiated neonates born to 20- to 25-year-old mothers, which is similar to the 59.2% and 61.8% found in India [29] and Pakistan [32] studies, respectively.

Regarding the fetal presentation of an asphyxiated neonate, 94.1% were cephalic, which was higher than studies carried out in Debre Markos [33] and Jimma [25], Ethiopia, where it was 71% and 82.9%, respectively. The SVD of asphyxiated neonates in this study accounted for 72.5%, which was higher than a study in India [34], where it was 32%, but lower than studies in Tigray [22], Gondar [35], Ethiopia, and Nigeria [30], where it was found to be 92.6%, 95.8%, and 78.9%, respectively. The difference might be because most cases in DCSH involve complicated and prolonged labor referred from other health centers, and cesarean and assisted vaginal delivery are preferred over SVD to reduce further feto-maternal complications.

Most asphyxiated neonates were delivered with normal birth weight (84.3%), which was slightly comparable to a study conducted in Jimma, Ethiopia [25], at which it was 82.6%, but higher than studies conducted in Brazil [36] and Nigeria [30], where the prevalence of normal birth weight among asphyxiated newborns was 43.6% and 57.4%, respectively. This difference may be due to differences in time, area of the study, and registration status of neonatal data.

The prevalence of stages I, II, and III HIE were 58.8%, 35.3%, and 5.9%, respectively. In contrast, a study conducted in India found that HIE-I, HIE-II, and HIE-III cases were 23.81%, 33.33%, and 42.86%, respectively, with death occurring in 33% of HIE cases [37]. The discrepancy might be due to the difference in knowledge levels of the

Table 3: Factors associated with PNA at NICU in DCSH, North-East Ethiopia (n=256), April 2019.

Variables	Birth Asphyxia		COR (95% CI)	AOR (95% CI)
	Asphyxiated (51)	Not asphyxiated (205)		
Labor duration				
Normal	25	10	1	1
Prolonged	26	195	18.75 (8.1-43.4)	18.53 (7.86-43.69) *
Place of delivery				
DCSH	28	155	2.55 (1.35-4.82)	2.48 (1.18-5.24) *
Other	23	50	1	1

[1]Reference category; *Significant at p-value <0.05

professionals rating the stages.

About the clinical features of perinatal asphyxia, being unable to cry (78.4%) after birth was the most common presentation. This was lower than the report of a study in Nigeria [30], where 89.4% of the asphyxiated newborns were unable to cry. 70.6% of asphyxiated neonates were discharged with some improvement, which is slightly higher than a study in Nigeria [30], where 63.9% of them were discharged. The low mortality in this study could be attributed to the lower prevalence of stage 3 HIE cases. Moreover, timely intervention by obstetricians and better care provided to an asphyxiated neonate could have contributed to the low mortality.

The ANC follow-up in this study was 94.1%, which was lower than a study conducted in three hospitals in North-Eastern Ethiopia (Dessie, Debre Birhan, and Woldia Hospitals) [38], where ANC follow-up was 97.1%, but higher than a study conducted in North-Central Ethiopia [24], where it was 71.53%. The disparity could be attributed to the difference in study duration, mom's knowledge of the benefits of ANC, and the number of ANC visits taken.

In terms of the relationship between various background factors and perinatal asphyxia, the odds ratio of developing perinatal asphyxia was 18.5 times higher in neonates of mothers who had a prolonged labor. This could be because if labor does not progress regularly, the woman may face major difficulties such as dehydration, fatigue, or uterine rupture, with a high likelihood that the fetus would become distressed. All of these conditions may result in birth asphyxia. Prolonged labor may also contribute to maternal infection, bleeding, and neonatal infection, which may also result in birth asphyxia in the babies. As a result, appropriate labor management to prevent prolonged labor with early interventions may lessen the risk of newborn asphyxia [35].

Those born in DCSH had a 2.5-fold higher risk of developing perinatal asphyxia than those born in other health facilities (lower-level facilities). This could be because of the high flow of mothers with complicated pregnancy and deliveries who are at high risk of developing perinatal asphyxia and are referred from various health institutions with a wide catchment since the hospital serves as a referral for the Afar, Tigray, and Amhara regions.

Limitations

Since this study was a retrospective document review, which only contains pertinent maternal data for neonates, it is prone to limitations in the generalizability of results.

Conclusion and Recommendation

The proportion of PNA was 19.9%, with a case fatality rate of about 19.6%. Prolonged delivery and delivery in a hospital were the significant factors affecting the occurrence of PNA. The risk factors for PNA can be reduced by providing adequate prenatal, antenatal, intrapartum, and neonatal care services with limited resources; i.e., immediate management of asphyxiated newborns, interventions for prenatal illnesses and problems, and strict labor follow-up are critical.

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