

Determinants of birth asphyxia among new born babies in Bekoji public hospital, Arsi zone, Oromia regional state, Ethiopia, 2023

Abstract

Background: Birth asphyxia stands out as a significant factor contributing to morbidity and mortality among newborns. However, the determinants of birth asphyxia have not been thoroughly investigated within the local context, particularly in this specific area. Hence, this study aims to identify these determinants to tackle the issue effectively.

Objectives: The goal of this study is to pinpoint the determinants of birth asphyxia at Bekoji Public Hospital in Bekoji Town, Arsi Zone, Oromia Region, Southeast Ethiopia, in 2023.

Methods: A case-control study was conducted between June 1, 2023, and August 30, 2023. A total of 198 newborns (75 cases and 123 controls) at Bekoji Public Hospital were selected using a systematic random sampling technique. Data collection involved a checklist for record review and an interviewer-administered questionnaire. The data were entered into Epi Data version 7.1 and analyzed using SPSS version 25. Variables with a P-value < 0.25 were subjected to multivariable regression analysis. The Odds Ratio estimated with a 95% Confidence Interval was utilized to indicate the strength of association, with a significance level set at $P < 0.05$.

Results: 196 mothers of newborns (73 cases and 123 controls) were interviewed, resulting in a response rate of 98.9%. Factors such as prolonged duration of labor (AOR=2.54; [95% CI: 1.78, 6.39]), delivery by Caesarean section (AOR=0.64; [95% CI: 0.004, 1.114]), presence of stained amniotic fluid (AOR=0.473; [95% CI: 0.180, 1.242]), and non-cephalic fetal presentation (AOR=2.12; [95% CI: 1.019, 3.80]) were identified as predictors of birth asphyxia. Additionally, being male (AOR=1.885; [95% CI: 0.899, 3.950]) was also found to be a predictive factor for birth asphyxia.

Conclusion and recommendations: Duration of labor, fetal presentation, type of amniotic fluid, mode of delivery, and the gender of newborns emerged as significantly associated factors with birth asphyxia. As a result, interventions targeting these factors, particularly focusing on duration of labor and fetal presentation, should be rigorously implemented.

Keywords: birth, asphyxia, new born, Bekoji, hospital, Ethiopia

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Introduction

Background

Birth asphyxia stands as a prominent contributor to neonatal mortality in low and middle-income countries, often leading to severe long-term consequences such as mental retardation, cerebral palsy, and various other neurodevelopmental disorders.¹

The occurrence of birth asphyxia arises when vital organs, notably the brain, fail to receive sufficient oxygen and nutrients, a critical requirement for their proper functioning. This deprivation can manifest before, during, or after the birthing process.²

In line with the International Classification of Diseases (ICD), the diagnosis of birth asphyxia hinges on the APGAR score—a composite assessment that evaluates Appearance/Color, Pulse/Heart rate, Grimaces/Reflexes, Activity/Muscle tone, and Respiration. A score below seven at the fifth minute denotes asphyxia, with varying severity levels rated as 0, 1, or 2 based on the components.³

Globally, approximately 2.5 million infants succumb within the initial twenty-eight days of life annually, encompassing nearly 47%

of all under-five deaths. Research findings underline birth asphyxia as the third leading cause of neonatal mortality, following closely behind infections and preterm birth.⁴ Each year, around 23% of neonatal deaths and 29% of early neonatal mortality cases worldwide are attributed to birth asphyxia.⁵

Expanding on the insights provided, according to the World Health Organization (WHO), birth asphyxia ranks as the third most prevalent cause of newborn mortality globally, trailing behind infections and premature births. In developing nations, particularly in regions like Asia and sub-Saharan Africa, birth asphyxia accounts for approximately 23%, 40%, and 34% of newborn deaths, respectively.⁶

Within Ethiopia, birth asphyxia plays a significant role in neonatal mortality, contributing to 31.6% of such fatalities.⁷ This statistic underscores the substantial impact of birth asphyxia on newborn health outcomes in the country.

Moreover, in Ethiopia specifically, birth asphyxia is responsible for over a third of newborn deaths.⁸ The repercussions of birth asphyxia extend beyond mortality, encompassing short and long-term neurodevelopmental sequelae, leading to cognitive and motor disabilities that oftentimes pose treatment challenges.^{9,10}

It is noteworthy that the majority of newborn deaths occur in developing countries, with South Asia and sub-Saharan Africa bearing the highest burden.⁴ Alarmingly, in developing nations, approximately 120 million newborns experience birth asphyxia annually, resulting in 900,000 deaths. Sub-Saharan African countries, in particular, witness birth asphyxia contributing to 24.0% of newborn fatalities.¹¹

In summary, birth asphyxia emerges as a prominent factor in neonatal mortality within low and middle-income countries, serving as a primary catalyst for both immediate and long-lasting health complications, including mental retardation, cerebral palsy, and various other neurodevelopmental disorders.¹⁰

Annually, 24% of neonatal deaths are attributed to birth asphyxia.¹² Studies from various regions such as Colombia, Nigeria, and southwest Ethiopia have reported prevalence rates of approximately 41%, 21%, and 12.5%, respectively.^{13,14}

In Ethiopia, the neonatal mortality rate remains high within sub-Saharan Africa.¹⁵ Although there was a 10% decrease in neonatal deaths between 2005 and 2016, there was a slight increase to 30 per 1000 live births in 2019.^{16,17}

The collective prevalence of perinatal asphyxia stands at 22.8%.¹⁸ Previous research in Dilla and Tigray, Ethiopia, indicated prevalence rates of 32.8% and 22.1%, respectively.^{19,20} Birth asphyxia is a major contributor to neonatal deaths in Ethiopia, accounting for 31.6%, followed by preterm birth (21.8%), and sepsis (18.5%).²¹

In developed countries, the proportion of birth asphyxia is 2 per 1000 live births, contrasting starkly with the more than tenfold higher rates in low-income countries with inadequate access to quality maternal and neonatal care.²² Sub-Saharan Africa, including Ethiopia, faces a high burden of neonatal deaths,²³ exemplifying the challenges in reducing neonatal mortality rates.

Studies from Tigray, Gondar, Dilla, and Jimma reported varying prevalence rates of birth asphyxia, further reflecting the complexity of this issue.²¹ The pooled umbrella review estimated a prevalence rate of 22.52%.²⁴

In Nigeria, Kenya, and Ethiopia, distinct prevalence rates of birth asphyxia were reported, emphasizing the regional disparities in healthcare outcomes.^{25,26} The prevalence in specific Ethiopian regions such as Dire Dawa, Jimma, and Gondar varied significantly.²⁷⁻²⁹ Nationally, birth asphyxia contributes to 31.6% of neonatal deaths in Ethiopia.^{30,31}

Despite this broad scope of data, information on the determinants of newborn asphyxia in the Arsi zone, particularly at Bekoji Hospital, remains limited. This study aims to identify these determinants, providing crucial insights to enhance healthcare providers' and women's understanding of birth asphyxia during labor. Perinatal asphyxia poses a significant clinical challenge with high morbidity and mortality rates, potentially leading to long-term neurological complications. Addressing this issue is paramount, especially in low-income countries where birth asphyxia accounts for a substantial portion of neonatal deaths globally and regionally.

Methods and materials

The study setting

The study took place at Bekoji Hospital in Bekoji town, located 56 kilometers south of Asella, the zonal seat in the Arsi zone. As of 2022, the town accommodates a total of 34,315 residents. Among them, females constitute 17,226 individuals, including 1,191 pregnant women.

Bekoji town offers two public healthcare facilities—a health center and a district hospital—to cater to the healthcare needs of its population. Additionally, the town hosts 11 drug stores and 19 private medium-sized clinics, expanding access to healthcare services.

On average, the hospital handles 190 deliveries and 40 neonatal intensive care unit (NICU) admissions each month, showcasing the medical services' substantial utilization within the community. Bekoji Hospital offers a range of services, including outpatient and inpatient care, maternal and child health services, delivery services, major and minor surgeries, NICU facilities, intensive care units, radiological services, and laboratory services, to address diverse healthcare needs for the local residents.

The study design and period

Institutional based Unmatched Case control study design was conducted in Bekoji Hospital from June 1/ 2023 to August 30/ 2023.

Source population

All alive newborns delivered at Bekoji Hospital were the source population for this study.

Study population

Newborn live babies who were born at Bekoji Hospital during the data collection period were the study population for this study.

The Cases and Controls will be identified from the medical records of the mother.

Cases: All asphyxiated newborns with APGAR scores of less than 7 at the 5th minute, delivered after 28 weeks of gestation and confirmed by the physician or Midwives during data collection time.

Controls: Newborns delivered after viability and not diagnosed with birth asphyxia (without asphyxia) who cry, breath without difficulty, not gasping, APGAR scores ≥ 7 at 5th minute and confirmed by the physician or Midwives during data collection time.

Study unit

The study unit of this study was individual which means babies born at Bekoji Hospital during data collection of this study period.

Inclusion and exclusion criteria

Inclusion criteria

All alive Newborns, who were born in Bekoji hospital during the study period were included in this study.

Exclusion criteria

Neonates born with congenital malformations and data with incomplete documentation//Client's card with incomplete/missed information will be excluded from this study.

Sample size determination

The sample size for the unmatched case-control study conducted at Bekoji Hospital was determined using statistical calculations in Epi Info 7 software. Several factors were taken into consideration:

1. For the determinants related to breech fetal presentation based on a previous study in West Shewa, Oromia region, with a proportion of controls exposed at 10.4% and an odds ratio of 5, the sample size was calculated to be 198 (75 cases and 123 controls). This calculation factored in a 95% confidence interval, 90% power of the study, a three-to-one control to case ratio, and a 5% non-response rate.

2. Considering the color of amniotic fluid and nuchal cord tightness based on a study in Jimma Zone, Oromia region, with specific proportions of controls exposed and odds ratios, the calculated sample sizes were 51 (17 cases and 34 controls) and 57 (19 cases and 38 controls) respectively. These calculations also considered

a 95% confidence interval, 90% power of the study, a two-to-one control to case ratio, and a 5% non-response rate. Given that the sample size of 198 was the largest among the three calculated sizes, it was chosen as the sample size for the study at Bekoji Hospital (Table 1).

Table 1 Sample size calculation for determinants of birth asphyxia among new born delivered in Bekoji Hospital/2023

Factors	Alpha	Power	Ratio of control to cases	% of control with exposure variables	% of cases with exposure variables	Odds ratio	Sample size		
							Case	Control	Total
Breech presentation	95	90	3	7%	27.30%	5	75	123	198
Color of amniotic fluid	95	90	2	24.50%	72.20%	8	17	34	51
Tight nuchal cord	95	90	2	24%	68.90%	7	19	38	57

Sampling procedure

1) Hospital selection: From a pool of seven hospitals, Bekoji Hospital was chosen using a lottery method, employing a simple random sampling technique to ensure fairness and randomness in the selection process.

Selection of participants:

Cases:

1) Every third newborn was included as a case (calculated as the total number of cases divided by 75).

Controls:

1) Every two newborns were selected as controls (calculated as the total number of controls divided by 123).

Participant selection process:

1) On the first day of data collection, the initial study participant was randomly chosen from the registration book at the time of discharge or transfer, employing a simple random sampling technique to commence the data collection process.

Data collection tools and procedure

The data were collected using an interviewer-administered structured questionnaire adapted from various literature sources, as well as a document review checklist. The socio-demographic and reproductive characteristics of the respondents were obtained through interviews, while intra-partum and neonatal characteristics were extracted from the medical records of the mothers using a checklist.

To ensure consistency, the questionnaire was initially prepared in English, then translated into the local language, Afan Oromo. It was later back-translated into English. Pre-testing of the questionnaire was conducted at Kersa General Hospital, with 5% of the target study population participating. Based on the results, necessary amendments were made. For instance, the question regarding ethnicity was removed, as the majority of mothers showed no interest when asked about their ethnicity. Additionally, a question related to height, which was not directly relevant to our subject matter, was also removed.

The data were collected by four BSc midwives and one supervisor who had experience working in the neonatal intensive care unit of the hospital. All the data collectors and the supervisor held either a BSc or MSc degree in Clinical Nursing or Midwifery.

Data collection procedures, techniques and analysis

The data was edited, coded, and entered into Epi Info version 7 software packages. It was then exported to the Statistical Package

for Social Sciences (SPSS) version 25 for analysis. Descriptive analysis was performed to calculate means with standard deviations, frequencies, and percentages.

Bivariate logistic regression analysis was conducted to examine the association of each independent variable with the outcome variable. Covariates with a cut-off p-value of less than 0.25 were used to screen candidate variables for the final model. The screened variables were then fitted into a multivariable logistic regression model using the backward stepwise method to control for confounders.

Adjusted odds ratios with 95% confidence intervals and a significance level of $p < 0.05$ were used to identify significant determinants of birth asphyxia. The model fitness was assessed using the Hosmer and Lemeshow goodness-of-fit test.

This facility-based unmatched case-control study was conducted from June 1 to August 30, 2023. Prior to data collection, a two-day training session was provided to the data collectors and supervisors. The training covered the purpose of the study, the questionnaire, data collection methods, and ethical considerations. Pretesting of the questionnaire was conducted on 5% of the sample size in an adjacent area (Kersa Hospital) before the actual data collection. Throughout the data collection process, close supervision was maintained by the supervisors and investigator. They checked the data for consistency, completeness, clarity, and accuracy on a daily basis. Additionally, they provided support to the data collectors to address any gaps and ensure the successful completion of the data collection.

Ethical consideration

The ethical approval was obtained from the Arsi University Health Science College Institutional Review Board, as well as a supportive letter from the Arsi Zonal Health Department.

The informed consent was obtained from the caregivers participating in the study. Providing a comprehensive explanation of the purpose and procedures of the study in local languages is crucial in obtaining informed consent.

To protect the privacy and confidentiality of the caregivers, it's commendable that the data collected will remain anonymous for an indefinite period of time. This helps to ensure the confidentiality of the participants and maintain their trust in the research process.

Result

In this study, a total of 196 mothers of newborns were interviewed and their records were reviewed, resulting in a response rate of 98.9%. Out of these, there were 73 cases and 123 controls.

The mean age of the mothers was found to be 28.26 years, with a standard deviation of 5.5.

In terms of the participants' residential area, 31 cases and 52 controls were from urban areas, while 42 cases and 71 controls were from rural areas.

Furthermore, among the study participants, 29 cases and 41 controls were between the ages of 17 and 25.

When considering the educational status of the respondents, 5 (6.8%) were unable to read and write, 24 (32.9%) had attended high

school, and 2 (2.7%) had a diploma or equivalent level of education (Table 2).

Out of a total of 181 cephalic presentations, 70 (38.7%) of the newborns were asphyxiated, while 111 (61.3%) were not asphyxiated. Among 73 cases, 11 (15%) of the mothers had a labor duration of less than 10 hours, while the remaining 62 (85%) had a labor duration greater than 10 hours. Of the total 196 mothers, approximately 153 (78%) had a spontaneous vaginal delivery (SVD), 16 (8%) had an emergency cesarean section, 14 (7%) had an elective cesarean section, and 13 (6.6%) had an instrumental delivery (Table 3).

Table 2 Socio-demographic characteristics of birth asphyxia among delivered in Bekoji Public Hospital/2023

Variables	Category	Cases=73	Control=123	Total
Residence of participants	Urban	31(42%)	52(42%)	83(42%)
	Rural	42(58%)	71(58%)	113(58%)
Educational status	cannot read and write	5(7%)	12(10%)	17(9%)
	can read and write	17(23%)	30(24%)	47(24%)
	elementary school(1-8)	21(29%)	44(36%)	65(33%)
	high school(9-12)	24(33%)	25(20%)	49(25%)
	diploma/level	2(3%)	11(9%)	13(7%)
	degree and above	4(5%)	1(1%)	5(3%)
	house wife	59(81%)	96(78%)	155(79%)
Occupational status	government worker	6(3%)	9(9%)	15(7%)
	Merchant	3(5%)	5(1%)	8(3%)
	student	5(7%)	13(11%)	18(9%)
Marital status	Married	69(95%)	118(96%)	187(95%)
	Single	4(5%)	4(3%)	8(4%)
Sex of neonate	Divorced	0(0%)	1(1%)	1(1%)
	Female	32(44%)	67(54%)	99(51%)
Average monthly income	Male	41(56%)	56(46%)	97(49%)
	700—3000birr	54(74%)	85(69%)	139(71%)
	3001—5300birr	15(21%)	32(26%)	47(24%)
	5301—7600birr	0(0%)	3(2%)	3(2%)
	>=7601birr	4(5%)	3(2%)	7(4%)
Age Distribution of Participants	17-25	29(40%)	41(33%)	70(36%)
	26-34	32(44%)	60(49%)	92(47%)
	>35	12(16%)	22(18%)	34(17%)

Table 3 Maternal Intrapartum factors in Bekoji Public Hospital/2023

Variables	Category	Cases=73	Control=123	Total
Type of fetal presentation	Cephalic	70(96%)	111(90%)	181(92%)
	non cephalic	3(4%)	12(10%)	15(8%)
	SVD	59(81%)	94(76%)	153(78%)
Mode of delivery	emergency CS	7(10%)	9(7%)	16(8%)
	elective CS	4(5%)	10(8%)	14(7%)
	Instrumental	3(4%)	10(8%)	13(7%)
Outcome of the delivery	Singleton	68(93%)	106(88%)	174(89%)
	Multiple	5(7%)	17(14%)	22(11%)
Duration of Labor	less than 10 hours	11(15%)	37(30%)	48(24%)
	greater than 10 hours	62(85%)	86(70%)	148(76%)
Problems Encountered during Pregnancy	No	61(84%)	101(82%)	162(83%)
	Yes	12(16%)	22(18%)	34(17%)
Who attended the labor?	Midwives	57(78%)	106(86%)	163(83%)
	emergency surgeon	13(18%)	14(11%)	27(14%)
Was the labour obstructed?	obstetricians/gynecologist	3(4%)	3(2%)	6(3%)
	No	71(97%)	111(90%)	182(93%)
	Yes	2(3%)	12(10%)	14(7%)

Table 3 Continued...

Variables	Category	Cases=73	Control=123	Total
What condition did mother face during labour?	cord prolapse	12(16%)	18(15%)	30(15%)
	CPD	3(4%)	5(4%)	8(4%)
	PROM	31(42%)	38(31%)	69(35%)
	Normal	27(37%)	62(50%)	89(45%)
What was the status of amniotic fluid?	Stained	28(38%)	32(26%)	60(31%)
	Unstained	45(62%)	91(74%)	136(69%)

Regarding the sex of neonate about 32(43.8%) of the cases sex was female while the rest 41(56.2%) was male. Regarding their birth weight, about 27(36.8%) of the cases were less than 2.5kg whereas the rest 46(63%) of the cases weight was greater than 2.5kg (Table 4).

Table 4 Neonatal related factors among delivered in Bekoji Public Hospital/2023

Variables	Category	Cases=73	Control=123	Total
Sex of neonate	Female	32(44%)	67(54%)	99(51%)
	Male	41(56%)	56(46%)	97(49%)
Birth weight of neonate	<2500mg	27(37%)	34(28%)	61(31%)
	>=2500mg	46(63%)	89(72%)	135(69%)
What was the gestational age of newborn	Term	55(75%)	100(81%)	155(79%)
	Preterm	8(11%)	11(9%)	19(10%)
	post term	10(14%)	12(10%)	22(11%)

From the total 196 mothers participated in the study 162(82.7%) them did not encounter the problem during their pregnancy period, while the rest 34(17%) of them encountered the problem during their pregnancy period (Table 5).

Table 5 Maternal medical related factors in Bekoji Public Hospital/2023

Variable	Category	Cases=73	Control=123	Total
Did you encounter problem during pregnancy	No	61(84%)	101(82%)	162(83%)
	Yes	12(16%)	22(18%)	34(17%)
If yes what condition did you encounter	Hypertension	3(4%)	3(2%)	6(3%)
	Diabetes	0(0%)	1(1%)	1(1%)
	Anemia	6(8%)	11(9%)	17(9%)
	Preeclamsia	1(1%)	6(5%)	7(4%)
	APH	2(3%)	1(1%)	3(2%)

From the total 196 of the mothers, about 74(37.8%) of them attended their first antenatal care services at first trimester gestational age while 87(44.4%) of them attended their first antenatal care services on their second trimester. From the total participants, about 29(14.8%) of the mothers did not attend their ANC visit for their current pregnancy while the rest 167(85.2%) attended their ANC visit for their current pregnancy. From those who attended their ANC visit, 11(6.5%), 33(20%), 49(29.3%), 103(61.7%) attended their ANC visit once, twice, three times and four times respectively. Regarding types of health facility, about 33(20%), 116(69.5%) and 4(2.4%) attended their ANC services in Hospital, health Center and health Posts respectively (Table 6).

From the total study participants, 63 neonates of the mothers who experienced labor duration of greater than 10 hours get asphyxiated. In similar manner, 71 neonates with cephalic presentation get asphyxiated. 29 of neonates with stained amniotic fluid get asphyxiated (Table 7).

Table 6 Maternal obstetrics related factors in Bekoji Public Hospital/2023

Variables	Category	Cases=73	Control=123	Total
The gestational age of mother at her first ANC visit	first trimester	27(37%)	47(38%)	74(38%)
	second trimester	34(47%)	53(43%)	87(44%)
	third trimester	9(12%)	23(19%)	32(16%)
Have you had ANC for current pregnancy	No	5(7%)	24(20%)	29(15%)
	Yes	68(9%)	99(80%)	167(85%)
Frequency of ANC mothers attended for current pregnancy	once	5(7%)	6(5%)	11(6%)
	twice	10(14%)	23(19%)	33(17%)
	three times	17(23%)	32(26%)	49(25%)
	four times	41(56%)	62(50%)	103(53%)
Type of Health facility that mother attended their ANC	public	58(79%)	101(82%)	159(81%)
	private	15(21%)	22(18%)	37(19%)
Number of pregnancy including the current.	1-3	58(79%)	90(73%)	148(76%)
	4-6	15(21%)	30(24%)	45(23%)
	>6	0(0%)	3(2%)	3(2%)
Where did you attend ANC visit?	hospital	16(22%)	17(14%)	33(17%)
	health center	38(52%)	78(6%)	116(59%)
	health post	1(1%)	3(2%)	4(2%)
	other	18(25%)	25(20%)	43(22%)

Regarding the labor duration of the mothers, about 48 (24.2%) had less than 10 hours of labor.

From the total study participants about 70(35.4%) of the others attended their first antenatal care service below 16 weeks of gestational age, about 64(32.3%) of the mothers attended their first antenatal care services between 16 and 28 weeks of gestational age Table 7.

Regarding delivery outcome, about 176(88.9%) of the study participants, their delivery outcome was singleton whereas the rest 22(11.1%) of the study participants' delivery outcome was multiples Figure 1.

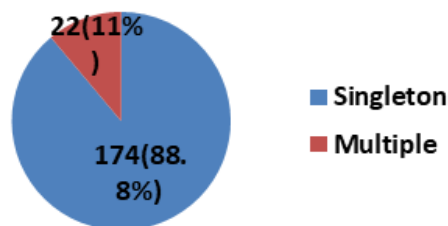


Figure 1 Delivery outcome of study participants in Bekoji Public Hospital/2023.

Table 7 The cross tabulation result of independent with dependent variables (Birth Asphyxia) among new born neonates in Bekoji Public Hospital/2023

Variables	Response	Asphyxiated	Not asphyxiated	Total
Labor duration	less than 10 hours	11	37	48
	greater than 10 hours	63	85	148
Sex of neonate	Female	32	66	98
	Male	42	56	98
What was the Presentation of the fetus?	Cephalic	71	110	181
	non cephalic	3	12	15
	SVD	60	93	153
What was the mode of delivery?	emergency CS	7	9	16
	elective CS	4	10	14
	Instrumental	3	10	13
What was the outcome of the delivery?	Singleton	70	105	175
	Multiple	4	17	21
What was the status of amniotic fluid?	Stained	29	32	61
	Unstained	45	90	135
What was the gestational age	Term	56	99	155
	Preterm	8	11	19
	post term	10	12	22
What condition did mother face during labour	cord prolapse	12	18	30
	CPD	3	4	7
	PROM	33	38	71
	Normal	26	62	88

Determinants of birth asphyxia

Based on the results from the binary logistic regression analysis:

1. Mothers who did not attend antenatal care services have 1.5 times higher odds that their newborn child experienced birth asphyxia compared to mothers who attended antenatal care services. However, it's important to note that the confidence interval for this finding ([95%CI: 0.197, 1.74]) includes 1, meaning that this difference may not be statistically significant.
2. The odds of developing birth asphyxia were more than three times higher in neonates whose mothers attended labor by midwives compared to those attended by other health professionals. This difference is statistically significant as the confidence interval does not include 1 ([95%CI: 0.319, 40.46]) (Table 8).

In the multi-variable logistic regression analysis conducted, several factors were found to be significantly associated with the occurrence of birth asphyxia. Here are the key findings:

- 1) **Duration of labor:** Newborns of mothers who experienced prolonged labor were 2.54 times more likely to develop birth asphyxia compared to those with normal labor (Adjusted Odds Ratio (AOR) = 2.54; 95% Confidence Interval (CI): 1.78, 6.39).
- 2) **Fetal presentation:** Neonates born with non-cephalic (non-head-first) presentation were 2.12 times more likely to develop birth

asphyxia than those with cephalic presentation (AOR = 2.12; 95% CI: 1.019, 3.80).

- 3) **Mode of delivery:** Neonates born via cesarean section (CS) had a lower likelihood of developing birth asphyxia, with an adjusted odds ratio of 0.064 (95% CI: 0.004, 1.114).
- 4) **Sex of neonate:** Male neonates were 1.8 times more likely to develop birth asphyxia compared to female neonates (AOR = 1.8; 95% CI: 0.899, 3.950).
- 5) **Types of amniotic fluid:** Neonates born to mothers with stained amniotic fluid had a lower likelihood of developing birth asphyxia, with an adjusted odds ratio of 0.473 (95% CI: 0.180, 1.242). These results suggest that factors such as prolonged labor, non-cephalic fetal presentation, male sex, and certain modes of delivery and types of amniotic fluid are associated with an increased risk of birth asphyxia. The odds ratios provide a measure of the strength of association between each factor and the outcome of interest (Table 9).

Table 8 The binary logistic regression (COR) analysis of birth asphyxia among new born in Bekoji Public Hospital/2023

Variables	P-value	COR	95% C.I. for EXP(B)	
			Lower	Higher
700—3000birr	0.24	2.061	0.444	9.563
3001—5300birr	0.23	2.667	0.532	13.378
Being house wife	0.21	1.086	0.816	1.444
Being single	0.127	0.758	0.247	2.323
Lost of child due to miscarriage	0.27	0.59	0.183	1.9
Not attending ANC	0.13	1.586	0.197	1.743
Attending ANC at Public health facility	0.24	0.85	0.345	2.093
Attending ANC at private health facility	0.168	1.642	0.812	3.321
Labor attended by Midwives	0.1301	3.593	0.319	40.468
Labor attended by Emergency surgeon	0.1505	2.364	0.188	29.707
Labor attended by By obstetrician/Gwyn	0.1638	2	0.112	35.807
Labor obstructed Yes	0.078	0.253	0.055	1.165
SVD Mode of delivery	0.255	0.462	0.122	1.748
Emergency CS	0.251	0.386	0.076	1.959
Elective SC	0.745	0.75	0.132	4.25
Non Cephalic presentation	0.15	0.385	0.105	1.413
Rural	0.957	1.016	0.568	1.816
Stained Amniotic fluid	0.063	0.558	0.302	1.032
Sex of neonate being male	0.154	1.523	0.854	2.714
Gestational Age <16 weeks	0.408	1.462	0.594	3.596
Gestational Age 16—28 weeks	0.829	1.146	0.332	3.953
Labor duration >10 hours	0.016	2.503	1.186	5.282

Table 9 Binary and Multiple logistic regression analysis result of birth asphyxia among new born child in Bekoji Public Hospital/2023

Variables	Category	COR (95% C.I.)	AOR (95% C.I.)	P-value
Fetal presentation	Non Cephalic	0.385(0.105-1.413)	2.124(1.019-3.808)	0.029
	Cephalic			
Mode of delivery	emergency CS	0.386(0.076-1.959)	.064(0.004-1.114)	0.039
	SVD			
Sex of neonate	Being male	1.523(0.854-2.714)	1.885(0.899-3.950)	0.023
	Being Female			
Labor duration	>10 hours	2.503(1.186-5.282)	2.540(1.009-6.395)	0.048
	< 10 hours			
Type of amniotic color	Stained amniotic fluid	0.558(0.302-1.032)	.473(0.180-1.242)	0.012
	Unstained amniotic fluid			

Discussion

Birth asphyxia is a significant issue contributing to neonatal mortality in low and middle-income countries, leading to long-term health complications like mental retardation, cerebral palsy, and other developmental disorders.¹⁰ Various factors play a role in the occurrence of birth asphyxia, with the duration of labor and fetal presentation identified as determinants in some studies. However, research from a neonatal intensive care unit (NICU) in Pakistan did not report these factors as maternal risk factors for birth asphyxia. This discrepancy could be attributed to socio-cultural differences, geographical variations, access to modern healthcare facilities, and differences in the mode of service delivery. It highlights the importance of understanding regional variations and addressing specific risk factors to prevent and reduce neonatal morbidity and mortality from birth asphyxia effectively.¹²

The findings of this study revealed that the sex of the neonate played a significant role in the likelihood of developing birth asphyxia. Specifically, male neonates were 1.8 times more likely to experience birth asphyxia compared to female neonates (Adjusted Odds Ratio [AOR] = 1.8; 95% Confidence Interval [95% CI]: 0.899, 3.950). However, a study conducted at Vanderbilt University Medical Center in the United States suggested that the sex of the neonate, particularly being male, was not linked to the occurrence of birth asphyxia.²² This discrepancy could be attributed to various factors such as socio-cultural differences, geographical variations, maternal awareness during pregnancy, technological advancements, and access to healthcare facilities.

Additionally, a study conducted in Debrebirhan indicated that mothers with limited literacy skills (AOR=4.7; 95%CI: 1.2, 11.9) were significantly more likely to have neonates with birth asphyxia compared to mothers with a college diploma or higher education. In contrast, the educational status of mothers in my study did not demonstrate a statistically significant association with birth asphyxia. This discrepancy may be explained by the prevailing high cultural pressures leading to lower educational attainment among mothers in the northern region of Ethiopia. However, it is worth noting that in my study population, over 90% of mothers had achieved literacy.³²

This study identified several statistically significant factors associated with birth asphyxia, including mode of delivery, non-cephalic presentation, stained amniotic fluid, and duration of labor. These findings align with a study conducted in the Gamogofa zone, which also found breech presentation, meconium-stained amniotic fluid, and instrumental delivery to be statistically significant factors. The similarity in results between the two studies may be attributed to socioeconomic factors and access to healthcare facilities.³³

Newborns of mothers who experienced prolonged labor were found to be at a higher risk of developing birth asphyxia compared to those with normal labor. In this study, the odds ratio was 2.54, (AOR=2.54; [95% CI: 1.78, 6.39]) while a study in Ilu Aba Bora reported an odds ratio of 4.12 (AOR 4.12; [95% CI 1.78, 9.49] for the same association. This increased risk may be due to factors such as inadequate pelvis size for the newborn's head to pass through or insufficient cervical effacement and contraction.

Furthermore, the study revealed that non-cephalic presentation was associated with a higher risk of birth asphyxia compared to cephalic presentation. The odds ratio for non-cephalic presentation was 2.12 (AOR=2.12; [95%CI: 1.019, 3.80), in this study, while a study in Ilu Aba Bora reported an odds ratio of 4.35 [AOR 4.35; 95% CI 1.77, 10.67].³⁴ This increased risk may be attributed to oxygen deprivation experienced by the fetus, leading to changes in fetal heart rate, decreased fetal movement, and increased meconium production, all contributing to the occurrence of birth asphyxia.

In my study, the mode of delivery by cesarean section (CS) was found to be 0.64 times more likely to result in birth asphyxia compared to spontaneous vaginal delivery (AOR = 0.64; 95% CI: 0.004, 1.114). However, a study conducted in the West Shewa zone reported that newborns delivered by CS had a higher risk of developing birth asphyxia, with an adjusted odds ratio (AOR) of 3.68 (95% CI: 1.31, 10.28). Additionally, babies delivered via vaginal assisted delivery had an even higher risk, with an AOR of 5.69 (95% CI: 2.17, 14.91), compared to those born through spontaneous vaginal delivery.³⁵

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Authors contributions

TG= Original draft preparation, Conceptualization, Methodology, Investigation, data curation.

MTA= Methodology, Software, Validation, Formal analysis, Review and editing.

DB= Methodology, Review and editing.

DSG= Methodology, Review and editing.

AKT=Analysis, Methodology.

HB= Original draft preparation, Conceptualization, Methodology, Review and editing.

HS= Original draft preparation, Conceptualization, Methodology, Formal analysis.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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