



## Research article

## Determinants of birth asphyxia among newborns in Northwest Ethiopia, 2019: case control study

Melkamu Senbeta Jimma<sup>a,\*</sup>, Kennean Mekonnen Abitew<sup>b</sup>, Ermias Sisay Chanie<sup>c</sup>, Fisha Alebel GebreEyesus<sup>d</sup>, Mengistu Mekonnen Kelkay<sup>e</sup><sup>a</sup> Department of Nursing, Colleges of Health Science, Assosa University, Ethiopia<sup>b</sup> Department of Emergency Medicine and Critical Care Nursing, School of Nursing, Colleges of Medicine and Health Sciences University of Gondar, Ethiopia<sup>c</sup> Department of Pediatrics and Child Health Nursing, College of Health Sciences, Debre Tabor University, Debre Tabor, Ethiopia<sup>d</sup> Department of Nursing, Colleges of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia<sup>e</sup> Department of Pediatrics and Child Health Nursing, School of Nursing, Colleges of Medicine and Health Sciences University of Gondar, Ethiopia

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## ABSTRACT

**Introduction:** Birth asphyxia is a condition of impaired gas exchange in newborns when the Apgar score is < 7 in the first 5 min. It accounts 31.6% of all neonatal deaths, and the leading causes of neonatal mortality in Ethiopia. Identifying its determinant factors is very important to prevent the problem.

Therefore, this study was aimed at identifying the determinant factors of birth asphyxia among newborns at Benishangul Gumuz region hospital.

**Methods and materials:** The hospital-based unmatched case-control study was done from March 04 to July 16, 2019 in Benishangul Gumuz Region Hospitals. Total sample size is 275 with 69 cases and 206 controls. Newborns with an Apgar score of less than 7 at 5 min were taken as cases, and those with greater or equal to 7 were taken as controls. All asphyxiated newborns were enrolled as cases, where as in every three-step non-asphyxiated newborns were taken as controls. The data was entered into Epi Info 7 and exported to SPSS for analysis. Bivariable logistic regression analysis was used. Those variables with a p-value <0.05 were identified as significant determinants of birth asphyxia.**Results:** In the current study, anemia during pregnancy [AOR = 2.95, 95% CI: (1.02, 8.54)], no ANC visit at all [AOR = 4.26, 95% CI: (1.23,14.7)], prolapsed cord [AOR = 4.52, 95% CI: (1.3, 21)], and low birth weight [AOR = 4.1, 95% CI: (1.11, 15.36)] were all determinant factors for birth asphyxia.**Conclusion:** and Recommendations: The identified determinants of birth asphyxia were anemia during pregnancy, no ANC visit at all, prolapsed cord, cesarean birth, and low birth weight.

Based on our study, most of identified determinant factors of birth asphyxia were preventable so, policy makers, clinicians, and other stakeholders need to invest their maximum effort on prevention of birth asphyxia.

## 1. Introduction

Birth asphyxia is a condition of impaired gas exchange in newborns at birth, when the Apgar score is < 7 at the first 5<sup>th</sup> minute [1, 2]. The Apgar score is an important tool used to check the condition of the neonate immediately after birth [2].

According to the World Health Statistics report of 2018, birth asphyxia was the commonest cause of neonatal deaths in 2016 [3].

In Brazil, birth asphyxia is the most common leading cause of under seven-day mortality, which was about 40.25% in 2005 and 32.38 percent

in 2010 [4]. In Sub-Saharan Africa, birth asphyxia is the second leading cause of neonatal mortality, which contributes to about 34% of the total [5].

In Nigeria, 28.8% of early neonatal age mortality was because of prenatal asphyxia [6]. In Kenyan hospitals, the prevalence was 5.1% [7], and the top diagnoses at admission (30%) were birth asphyxia for all admissions [8].

In Ethiopia, birth asphyxia was the leading cause of neonatal death, which accounted for about 31.6% of all neonatal deaths in 2015 [9].

The prevalence of birth asphyxia in Dire-Dawa Ethiopia was 2.5% (25/1000 live births) [10]. In Jimma Zone, Ethiopia, birth asphyxia was

\* Corresponding author.

E-mail address: [melkasen12@gmail.com](mailto:melkasen12@gmail.com) (M.S. Jimma).<https://doi.org/10.1016/j.heliyon.2022.e08875>

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a leading cause for neonatal mortality by approximately 47.5% [11]. In the northern part of Ethiopia, Gondar, its prevalence was 13.8% [12].

According to different studies, maternal age and level of education, number of antenatal care visits, type of labor, anemia during pregnancy, pregnancy-induced hypertension (PIH), maternal asthma, Gestational diabetic mellitus (GDM), meconium staining, duration of labor, mode of delivery, rapture of membrane (ROM), presentation, cephalo pelvic disproportion (CPD), birth attendant, gestational age, birth weight, fetal distress are the common determinant variables [4, 12, 13, 14, 15, 16, 17, 18, 19, 20].

Most of studies conducted in different areas were cross-sectional. Our study area is really different from regions of Ethiopia in geographical location, sociodemographic characteristics, infrastructure of health service, community culture and diversity. And also, there is one new variable (maternal asthma) added to our study that is not incorporated to different studies conducted in Ethiopia. Therefore, further research is required for identifying and knowing the determinant factors of birth asphyxia which helps to intervene with the identified determinant factors at Benishangul-Gumuz regional state hospitals.

Finally, this study has provided valuable information for health professionals, health facilities, regional health bureaus, researchers, planners, policy makers, partners, and other stakeholders.

## 2. Objective

To identify the determinants of birth asphyxia among newborns in Northwest Ethiopia, 2019.

## 3. Methods and materials

### 3.1. Study design and period

A hospital-based unmatched case control study was conducted from March 04 to April 16, 2019 at Benishangul-Gumuz region general and primary hospitals.

### 3.2. Study setting

Benishangul-Gumuz is one of the nine regional states of Ethiopia which is found in the northwest part of the country. The capital city is Assosa, which is far from the Ethiopian capital city, Addis Ababa, by 632 km. Based on the 2007 census conducted by the central statistical agency of Ethiopia (CSA), the Benishangul-Gumuz Region has a total population of 784,345, consisting of 398,655 men and 385,690 women: urban inhabitants number 105,926 or 13.51% of the population [21]. According to the 2016 EDHS report, the fertility rate of the region was 4.4% [22]. In the region, there are two general hospitals, two primary hospitals, 15 health centers, 14 health posts, 3 medium clinics, and 11 lower clinics that are available and serve an approximately projected population of 1,127,00 in 2018 [23].

### 3.3. Source population

All newborns in Benishangul Gumuz region were taken as the source population.

### 3.4. Study population

All newborns in Benishangul Gumuz region hospital during the study period were taken as the study population.

### 3.5. Inclusion and exclusion criteria

#### 3.5.1. Inclusion criteria

All newborns with gestational age >28 weeks in Benishangul region hospital will be included in the study.

**3.5.1.1. Cases and controls.** Newborns who had asphyxia or Apgar score <7 at the first 5<sup>th</sup> minute were enrolled as cases and those with Apgar scores of ≥7 at the first 5<sup>th</sup> minute were included as controls. Referred mother paired neonates with complete referral form were enrolled to our study.

#### 3.5.2. Exclusion criteria

**3.5.2.1. Cases and controls.** Were newborns with major and visible congenital malformations such as hydrops, fetal and neural tube defects, and critically ill mothers. And also, participants with incomplete chart and those mothers who have no reliable LNMP or early ultrasound were excluded from the study.

## 3.6. Sample size determination

Sample size was calculated by using a double population proportion formula

$$n = 2 \times \frac{(\bar{p})(1 - \bar{p})(Z_{\beta} + Z_{\alpha/2})^2}{(p_1 - p_2)^2}$$

where  $\bar{p} = p_1 + p_2 / 2$ .

- > n = desired sample size
- > Z = standard normal distribution usually set at 1.96
- > β = power = 0.80 or 80%, Z β = 0.84
- > P1 = Percentage of controls exposed = 15.9%
- > P2 = Percentage of cases exposure = 34.1%.

By calculating deferent variables from deferent study areas, a study conducted in Tigray Central zone, a variable which was unable to read and write, came with the highest sample size and taken as P-value.

EPI Info software version 7 was used to calculate the sample size with the following parameters for unmatched case-control study: confidence level = 95%, power = 80%, Crud odds ratio = 2.571, control to case ratio = 3:1; percentage of controls exposed = 15.9% and the percentage of cases exposed = 34.1% [19]. After considering a nonresponse rate of 10%, the sample size for cases was 69, the sample size for controls was 206, so the overall sample size was 275 (69 cases and 206 controls) as shown below in (Table 1).

### 3.7. Sampling procedure

Study samples for controls were selected by using a systematic sampling technique and for cases were all newborns that had birth asphyxia without using any sampling technique. The sample selection was conducted and the participants were allocated into mother-newborn paired, who came to the study hospitals for delivery starting from the first date to the end of data collection.

Samples were taken from a total of 794 newborns. From these, 720 newborns without birth asphyxia were reported from all four hospitals, and those were taken as expected newborns at the time of data collection.

From this source population, the proportional allocation formula was used to select controls from each hospital by using a systematic sampling technique and the k value for the four hospitals was approximately the same (k ≈ 3) and each sample was drowned from each respective site.

All cases (asphyxiated newborns) were taken without using any sampling technique.

For control (proportionate allocation)  $n_i = (n/N) \times N_i$

where; n = total sample size to be selected, N = total population,  $N_i$  = total population of each hospital, and  $n_i$  = sample size from each hospital. Finally, a total of 275 (206 control samples and 69 cases) were drowned from all hospitals.

**Table 1.** Sample size for variables (factors) of birth asphyxia from studies.

Study areas	Factors or variables	Percentage of controls exposed (P1)	Percentage of cases exposure (P2)	COR	Sample size (n)
University of Gondar hospital	Cesarean birth	8.3%	37.8%	COR = 8.73	90
	Prolonged duration of labour	31.1%	60.0%	COR = 3.24	136
	Fetal heart rate, in bpm <100	22%	78%	COR = 11	42
	Wt < 2.5kg	5%	24.4	COR = 6.15	144
Tigray central zone Hospitals	Unable to write and read	15.9%	34.1%	COR = 2.571	250
	Meconium-stained birth	5.1%	23.9%	COR = 5.816	152
	GA<37wk	22.7%	55.7%	COR = 4.272	100
	Wt < 2.5kg	10.5%	48.9%	COR = 7.896	64

## 4. Variables

### 4.1. Dependent variable

Birth asphyxia (Yes/No).

### 4.2. Independent variable

**Socio-demographic factors** (maternal age, ethnicity, place of residence, marital status, education status, maternal occupational status).

**Ante-partum related factors** (pregnancy-induced hypertension, anemia during pregnancy, maternal asthma, parity, gravidity, number of ANC visits, and ante-partum hemorrhage).

**Intra-partum related factors** (labor attendant, rupture of membrane, cord prolapse, cephalo-pelvic disproportion, duration of labor, mode of delivery, meconium staining, presentation, type of labor) and

**Newborn related factors** (sex of newborn, gestational age, fetal distress, birth weight, type of birth).

### 4.3. Operational definitions

**Birth asphyxia**, is a condition of impaired gas exchange in neonates at birth, when the apgar score is < 7 at the first 5<sup>th</sup> minute [1, 2].

**Cases (asphyxiated):** Neonates born in the studied hospitals and diagnosed as asphyxia by an attendant professional with an apgar score of <7 at the first 5<sup>th</sup> minute.

**Controls (not asphyxiated):** Neonates born in the studied hospitals and classified as not asphyxiated ones by the attendant professionals with an apgar score of  $\geq 7$  at the first 5<sup>th</sup> minute.

**Prolonged labor:** occurs when labor lasts for approximately 20 h or more if you are a first-time mother, and 14 h or more if you have previously given birth.

**Premature rupture of membranes:** there is the rupture of the membrane before 1 h of the beginning of labor [24].

**Low birth weight:** defined as one whose birth weight is less than 2,500 gm [25].

**Preterm birth:** A live-born infant born before 37 completed weeks of gestation [25].

**Anemia:** Is when hemoglobin level is less than or equal to 11 g/dl during third trimester [26].

### 4.4. Data processing and analyses

First, the data was checked for completeness and consistency. The collected data was entered into Epi-info version 7 and exported to SPSS version 20.0 for analysis. The entered data was cleaned and managed before going to analysis. First, bivariable logistic regression analyses were used to check the presence or absence of an association between dependent and independent variables. Multicollinearity was checked by using standard error and there is no any variable which has multicollinearity. Multivariable logistic regression analyses were done for variables with a p-value of less than 0.2 in bivariable analysis. For

multivariable analysis, the output adjusted odds ratio (AOR) with 95% CI and p-value <0.05 was used to identify determinants of birth asphyxia.

### 4.5. Ethical considerations

Ethical clearance was obtained from the School of Nursing's ethical review committee on behalf of University of Gondar. Then, an official letter was written for each hospital of Benishangul Gumuz region hospitals and submitted to managers. Written letters were addressed to concerned data collection units, which were obtained from each hospital higher manager.

Before the beginning of data collection, mothers of newborns were well informed about the study objectives, procedures to be followed, time of stay, about their right to refuse or discontinue participation whenever they wanted, and about confidentiality. To start data collection, written consent was obtained from mothers of newborns. For consent purposes, the first page of the consent letter was attached to each questionnaire. Lastly, after the interview had been finished, all participants were thanked for their participation in the study and participants with cases were advised and reassured for their child's problems.

Finally, we have eight observers in the four governmental hospitals. Four of them were observed during the daytime and another four were also observed during the night.

## 5. Results

### 5.1. Socio demographic characteristics

A total of 275 participants were included in the study with a 100% response rate. The median ages of the mothers of cases and controls were 25 (IQR  $\pm 6$ ) and 26 (IQR  $\pm 7$ ) years, respectively.

In cases, about 67 (97.1%) and in controls, about 128 (88.3%) of mothers gave birth in the same age range, 18 to 34. About 36 (52.2%) of the mothers of cases and 128 (62.1%) of controls were from urban areas. Thirty-six (52.2%) mothers of cases and 75 (36.4%) mothers of controls didn't have any formal education. Moreover, 22 (31.9%) of the mothers of cases were farmers, and 49 (23.8%) of the controls were governmental employers (Table 2).

### 5.2. Ante-partum related factors

Thirty-one (44.9%) of the mothers in the case and 108 (52.2%) of the controls had a number of parities between two and four. Twenty-five (36.2%) of the mothers of cases had no any ANC visits at all and 114 (55.3%) of the controls had 4 ANC visits (Table 3).

### 5.3. Intra-partum related factors

Delivery of 30 (43.5%) mothers of cases and 118 (57.3%) of control of mothers were attained by midwives. Around half of the cases of newborns and more than 3/4<sup>th</sup> of the controls was delivered without having meconium staining.

**Table 2.** Socio-demographic characteristics of study participants with asphyxia among newborns in Benishangul Gumuz region hospitals, northwest Ethiopia, 2019.

Variables	Category	Cases (n = 69)		Controls (n = 206)	
		Frequency	Percent (%)	Frequency	Percent (%)
Maternal Age	15–17	-	-	-	-
	18–34	67	97.1	182	88.3
	≥35	2	2.9	24	11.7
Ethnicity	Shinasha	9	13	42	20.5
	Amhara	34	49.3	77	37.6
	Oromo	6	8.7	25	12.2
	Gumuze	8	11.6	22	10.7
	Berta	12	17.4	39	19
Residence	Urban	36	52.2	128	62.1
	Rural	33	47.8	78	37.9
Marital Status	Single	3	4	15	7.3
	Married	60	87.3	173	84
	Divorced	6	8.7	18	8.7
Education status	No formal education	36	52.2	75	36.4
	Elementary	12	17.4	40	19.4
	Secondary school+	21	30.4	91	44.2
Occupation status	Farmer	22	31.9	48	23.3
	Merchant	15	21.7	40	19.4
	Government employee	12	17.4	49	23.8
	House wife	14	20.3	52	25.2
	Daily Laborers &	6	8.7	17	8.3
	Others				

About 36 (52.2%) of cases had clean meconium, whereas 33 (47.8%) cases of newborns had meconium staining, and 170 (82.5%) of controls had clean meconium, whereas 36 (52.2%) of controls had meconium staining. From the total cases, 15 (51.7%) and from the total controls, 14 (48.3%) had cord prolapse. For cases and controls, those mothers who

**Table 3.** Ante-partum related factors of birth asphyxia among newborns in Benishangul Gumuz region hospital, northwest Ethiopia, 2019.

Variables	Category	Cases (n = 69)		Controls (n = 206)	
		Frequency	Percent (%)	Frequency	Percent (%)
Gravidity	1	26	37.7	72	35
	2–4	33	47.8	116	56.3
	≥5	10	14.5	18	8.7
Parity	1	30	43.5	83	40.3
	2–4	31	44.9	108	52.4
	≥5	8	11.6	15	7.3
Number of ANC visit	No ANC Visit at all	25	36.2	19	9.2
	1-3 visits	23	33.3	73	35.4
	4 visits	21	30.4	114	55.3
Anemia	Yes	18	26.1	21	10.2
	No	51	73.9	185	89.8
Asthma	Yes	8	11.6	1	0.5
	No	61	88.4	205	99.5
APH	Yes	1	1.4	0	0
	No	68	98.6	206	100
GDM	Yes	6	8.7	1	0.5
	No	63	91.3	205	99.5
PIH	Yes	10	14.5	1	0.5
	No	59	85.5	205	99.5

**Table 4.** Intra partum related factors of birth asphyxia among newborns in Benishangul Gumuz region hospitals, northwest Ethiopia, 2019.

Variables	Category	Cases (n = 69)		Controls (n = 206)	
		Frequency	Percent (%)	Frequency	Percent (%)
Labor attendants	Medical Doctor	22	31.9	44	21.4
	IESO	17	24.6	44	21.4
	Midwife	30	43.5	118	57.2
Labor augmented	Yes	38	55.1	66	32.1
	No	31	44.9	140	68.9
Duration of labor	Normal	58	84.1	190	92.2
	Prolonged	11	15.9	16	7.8
Meconium staining	Clear	36	52.2	170	82.5
	Stained	33	47.8	36	17.5
Cord prolapses	Yes	15	21.7	14	6.8
	No	54	78.3	192	93.2
Mode of birth	SVD	38	55.2	147	71.3
	Instrumental	15	21.6	37	18
	CS	16	23.2	22	10.7
Rapture of membrane	Normal	38	55.1	170	82.9
	Prolonged	31	44.9	35	14.1
CPD	Yes	1	1.4	0	0
	No	68	98.1	206	100
Presentation	Vertex	56	81.2	201	97.6
	Non-Vertex	13	18.8	5	2.6

gave birth through spontaneous vaginal delivery were 38 (55.2%) and 147 (71.3%), respectively (Table 4).

5.4. Newborn related factors

From total of newborn babies, 36 (52.2%) and 127 (61.7%) were females from cases and males from controls, respectively. In this study preterm cases accounts 13 (18.8%) and preterm controls were 8 (3.9%), whereas terms cases account 47 (81.2%) and term controls were 198 (86.1%).

The median weight of newborns in cases and controls was 3000 g (IQR±1075) and 3200 g (IQR±700) respectively. From cases macro-somic newborns were around 12 (17.4%) and from controls it accounts 13 (6.3%) (Table 5).

**Table 5.** Newborn related factors of birth asphyxia among newborns in Benishangul Gumuz region hospitals, northwest Ethiopia, 2019.

Variables	Category	Cases (n = 69)		Controls (n = 206)	
		Frequency	Percent (%)	Frequency	Percent (%)
Sex of newborn	Male	33	47.8	127	61.7
	Female	36	52.2	79	38.3
Gestational age	Preterm	13	18.8	8	3.9
	Terms	47	68.1	186	90.3
	Post term	9	13	12	5.8
Fetal distress	Yes	11	15.9	7	3.4
	No	58	84.1	199	96.6
Birth weight	<2500 gm	18	26.1	10	4.9
	2500-4000 gm	39	56.5	183	88.8
	≥4000	12	17.4	13	6.3
Type of birth	Singleton	58	84.1	192	93.2
	Twin Birth	11	15.9	14	6.8

**Table 6.** Bivariable and multivariable logistic regression analysis for determinants of birth asphyxia.

Variables	Birth Asphyxia		Crude OR (95% CI)	Adjusted OR (95% CI)
	Case (n = 69)	Control (n = 206)		
<b>Education status</b>				
No formal education	36 (32.4%)	75 (67.6%)	2.08 (1.12, 3.86)	1.9 (0.71, 5)
Elementary	12 (23.1%)	40 (76.9%)	1.30 (0.58, 2.896)	1.88 (0.6, 5.79)
Secondary school+	21 (18.8%)	91 (81.2%)	1	1
<b>Residence</b>				
Urban	36 (22%)	128 (78%)	1	1
Rural	33 (29.7%)	78 (70.3%)	1.50 (0.86, 2.60)	0.5 (0.19,1.32)
<b>Anemia</b>				
Yes	18 (46.2%)	21 (53.8%)	3.11 (1.54, 6.27)	2.95(1.02, 8.54) *
No	51 (21.6%)	185 (78.4%)	1	1
<b>Number of ANC visit</b>				
No ANC visit at all	25 (56.8%)	19 (43.2%)	7.14 (3.35, 15.22)	4.26(1.23,14.7)**
1-3 visits	23 (24%)	73 (76%)	1.71 (0.88, 3.31)	1.08 (0.42, 2.82)
4 visits	21 (15.6%)	114 (84.4)	1	1
<b>Labor attendants</b>				
Medical Doctor	22 (33.3%)	44 (67.7%)	1.96 (1.02, 3.76)	1.69 (0.49, 5.76)
IESO	17 (27.9%)	44 (72.1%)	1.52 (0.76, 3.02)	0.66 (0.19, 2.28)
Midwife	30 (20.3%)	118 (79.7)	1	1
<b>Labor augmented</b>				
Yes	38 (36.5%)	66 (63.5%)	2.6 (1.48, 4.54)	2.13 (0.89, 5.09)
No	31 (18.1%)	140 (81.9%)	1	1
<b>Duration of labor</b>				
Normal	58 (23.4%)	190 (76.6)	1	1
Prolonged	11 (40.7%)	16 (59.3%)	2.25 (0.99, 5.12)	1.48 (0.38, 5.81)
<b>Meconium staining</b>				
Clear	36 (17.5%)	170 (82.5%)	1	1
Stained	33 (47.8%)	36 (52.2%)	4.32 (2.39, 7.837)	2.17 (0.92,5.14)
<b>Cord prolapsed</b>				
Yes	15 (51.7%)	14 (48.3%)	3.81 (1.73, 8.38)	4.52(1.34,15.18)**
No	54 (22%)	192 (78%)	1	1
<b>Mode of delivery</b>				
SVD	38 (20.5%)	147 (79.5%)	1	1
Instrumental	15 (28.8%)	37 (71.2%)	1.57 (0.78, 3.15)	1.71 (0.61, 4.74)
CS	16 (42.1%)	22 (57.9%)	2.82 (1.35, 5.8)	5.23(1.3, 21)**
<b>ROM</b>				
Normal	38 (82.8%)	183 (17.2%)	1	1
Prolonged	31 (58.5%)	22 (41.5%)	6.78 (3.54, 12.98)	2.12 (0.86, 5.26)
<b>Sex of newborn</b>				
Male	33 (20.6%)	127 (79.4)	1	1
Female	36 (31.3%)	79 (68.7%)	1.75 (1.01, 3.03)	1.66 (0.72, 3.79)
<b>Gestational age</b>				
Preterm	13 (61.9%)	8 (38.1%)	6.43 (2.52, 16.41)	1.79 (0.33, 9.58)
Term	47 (20.2%)	186 (79.8%)	1	1
Post term	9 (42.9%)	12 (57.1%)	2.968 (1.18,7.46)	2.36 (0.64,8.69)
<b>Birth weight</b>				
<2500 gm	18 (26.1%)	10 (4.9%)	8.44 (3.62, 19.7)	4.1(1.11, 15.36) *
2500 gm-3999 gm	39 (17.6%)	183 (82.4%)	1	1
≥4000 gm	12 (48%)	13 (52%)	4.33 (1.84,10.21)	3.16 (0.87,11.39)
<b>Type of birth</b>				
Singleton	58 (23.2%)	192 (76.8%)	1	1
Twin Birth	11 (44%)	14 (56%)	2.6 (1.2, 6.04)	1.31 (0.35, 4.92)

Key = \*p-value <0.05, \*\*p-value <0.025.

### 5.5. Determinants of birth asphyxia

After adjustment for possible effects of confounding variables, anemia during pregnancy, and no ANC visit at all, cord prolapse, cesarean birth,

and low birth weight were identified as significant determinants of birth asphyxia.

Newborns born from mothers who had anemia during pregnancy had a 2.9-fold increased risk of developing birth asphyxia when compared to

those born from mothers who did not have anemia during pregnancy [AOR = 2.95, 95% CI: (1.02, 8.54)].

The risk of birth asphyxia was found to be 4.2 times higher in newborns whose mothers had no ANC visits at all when compared to those whose mothers had four ANC visits [AOR = 4.26, 95% CI: (1.23,14.7)].

In asphyxiated newborns, having cord prolapse was found to be 4.5 times more likely than in those newborns who did not have cord prolapse [AOR = 4.52, 95% CI: (1.34,15.18)].

Newborns delivered by cesarean birth were 5.2 times more likely to develop birth asphyxia when compared to those who were delivered through spontaneous vaginal birth [AOR = 5.23, 95% CI: (1.3, 21)].

Low birth weight newborns were 4.1 times more likely than normal birth weight newborns to develop birth asphyxia [AOR = 4.1, 95% CI: (1.11, 15.36)] (Table 6).

## 6. Discussion

Birth asphyxia is the leading cause of mortality for about 3/4<sup>th</sup> neonates in their first 28 days of birth in Ethiopia. Therefore, care delivered to mothers before, during, and after birth of newborns is mandatory to reduce overall newborn morbidity, mortality and short and long-term consequences. In this study, determinants of birth asphyxia among newborns at Benishangul Gumuz region hospitals were clearly identified.

From ante-partum-related factors, anemia during pregnancy was identified as the determinant of birth asphyxia. Neonates born to anemic mothers had a 2.9-fold increased risk of developing birth asphyxia [AOR = 2.95, 95% CI: (1.02, 8.54)] when compared to mothers who did not have anemia during pregnancy. This finding was consistent with studies conducted in Banda Aceh, Indonesia [27], a tertiary care hospital in Pakistan [28], an India hospital [29], and teaching hospital in the capital city of Bangladesh [30].

In fact, the effect of intra-partum hypoxia through disruption of maternal and fetal oxygen transport causes asphyxia [27, 31] and also it might be due less oxygen carrying capacity of hemoglobin to the fetus.

The risk of birth asphyxia was 4.2 times greater in newborns whose mothers had no ANC visits at all when compared to those newborns whose mothers had four ANC visits [AOR = 4.26, 95% CI: (1.23,14.7)]. This finding was in line with the study conducted at Jimma zone public hospitals [32] and Isra University Hospital [31].

In fact, asphyxia was higher among newborn babies whose mothers did not receive counseling during pregnancy [33] and if mothers didn't attained ANC fill-up at all, they will not get quality of care, lack awareness about the health benefits of antenatal care, recognize their pregnancy lately [34].

Neonates with cord prolapse were 4.5 times more likely to have birth asphyxia than those who were not [AOR = 4.52, 95% CI: (1.34,15.18)]. This finding was in line with those studies conducted at Port Royal maternity Unit, Cochin Hospital [35], Rural District Hospital of Matiari, Pakistan [15], and Mercy Hospital and Medical Center, Chicago, IL, USA [35]. This might be due to its direct effect on supply of blood and oxygen to the fetus.

Cesarean birth was confirmed as the determinant factor for asphyxia. Neonates delivered by cesarean birth were 5.2 times more likely to develop birth asphyxia when compared to those newborns who were delivered through spontaneous vaginal birth [AOR = 5.23, 95% CI: (1.3, 21)]. This finding was in line with those studies conducted in University of Gondar referral hospital [2], Malugo Hospital, Kampala, Uganda [36], combined military hospital Multan, Pakistan [28] and Indonesia's Dr. Soetomo Hospital, Surabaya [37], These reference studies revealed that there were from three to seven times the risk of developing asphyxia.

In fact, this rate was due to prolonged uterine incision time during cesarean birth and anesthesia, which has lowered the apgar score, emergent caesarian birth [38]. During cesarean birth, the fetus's chest will not be squeezed, so the clearance of the lung by evacuating secretion is not as efficient as that of vaginal birth.

Low birth weight was also found to be a determinant of birth asphyxia. Low birth weight newborns were 4.1 times more likely to

develop birth asphyxia than normal birth weight newborns [AOR = 4.1, 95% CI: (1.11, 15.36)]. This finding was consistent with those studies conducted at Malugo hospital, Kampala, Uganda [36], Gondar University teaching hospital [12, 20, 38], Tigray central zone hospitals [19] Vali-e Asr hospital, Tehran, Iran [39], Indonesian Airlangga University Dr. Soetomo hospital, Surabaya [37], Jimma zone public hospitals [32], and rural hospitals in Bangladesh [40], These reference studies had the risk of developing birth asphyxia by one to fifteen folds.

This rate occurred due to hayalin membrane problems, surfactant deficiency disorder, or immature surfactants [41].

## 7. Conclusion

The identified determinants of birth asphyxia were anemia during pregnancy, no ANC visit at all, prolapsed cord, cesarean birth, and low birth weight. Based on our study, most of identified determinant factors of birth asphyxia were preventable so, policy makers, clinicians, and other stakeholders need to invest their maximum effort on prevention of birth asphyxia.

### 7.1. Limitation of the study

APGAR score is a tool used for classifying birth asphyxia so, there may be probability of misclassification of case and controls between health care providers. And also, this study might fill a variety of gaps in information regarding the determinants of birth asphyxia in the study population and helps policymakers to consider contextual interventions.

## 8. Ethics approval and consent to participate

Ethical clearance was obtained from the school of nursing's ethical review committee on behalf of the University of Gondar. Then, an official letter with reference number S/N/6000/06/2011 Ethiopian calendar was written for each hospital of Benishangul Gumuz and submitted to managers. Written letters were addressed to the concerned data collection units, which were obtained from each hospital's higher managers. Moreover, confidentiality of the information gathered from every study participant was guaranteed by all data collectors, supervisors, and investigators using code numbers rather than personal identifiers, and keeping the questionnaire locked and password protected on the data PC.

## 9. Consent for publication

Not applicable.

## 10. Availability of data and materials

The data used and analyzed during the current study are available on the main document and will be seen from the corresponding author on reasonable request.

## Declarations

### Author contribution statement

Melkamu Senbeta Jimma and Mengistu Mekonnen Kelkay: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Kennean Mekonnen Abitew, Ermias Sisay Chanie and Fisha Alebel GebreEyesus: Conceived and designed the experiments; Wrote the paper.

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### Data availability statement

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

### References

- [1] M.A. Rainaldi, J.M. Perlman, Pathophysiology of birth asphyxia, *Clin. Perinatol.* 43 (3) (2016 Sep 1) 409–422.
- [2] L. Liljeström, Birth Asphyxia: Fetal Scalp Blood Sampling and Risk Factors for Hypoxic Ischemic Encephalopathy, Doctoral dissertation, Acta Universitatis Upsaliensis, 2018.
- [3] Organization WH. World Health Statistics 2018: Monitoring Health for the SDGs, Sustainable Development Goals.
- [4] L.P. Garcia, C.M. Fernandes, J. Traebert, Risk factors for neonatal death in the capital city with the lowest infant mortality rate in Brazil, *J. Pediatr.* 95 (2) (2019 Apr) 194–200.
- [5] I. Ahmed, S.M. Ali, S. Amenga-Etego, S. Ariff, R. Bahl, A.H. Baqui, N. Begum, N. Bhandari, K. Bhatia, Z.A. Bhutta, G. Biemba, Population-based rates, timing, and causes of maternal deaths, stillbirths, and neonatal deaths in south Asia and sub-Saharan Africa: a multi-country prospective cohort study, *Lancet Glob. Health* 6 (12) (2018 Dec 1) e1297–e1308.
- [6] G.D. Forae, O.J. Uchendu, A.P. Igbe, An audit of paediatric mortality patterns in a Nigerian teaching hospital, *Niger. Med. J. Asso.* 55 (2) (2014) 130.
- [7] D.M. Gichogo, F. Murila, M. Matiang'i, W. Ndege, K. Bosire, Prevalence of asphyxia and readiness for neonatal resuscitation in Kenya, *Afr. J. Midwifery Women's Health* 12 (1) (2018 Jan 2) 21–27.
- [8] J. Aluvaala, D. Okello, G. Murithi, L. Wafula, L. Wanjala, N. Isika, A. Wasunna, F. Were, R. Nyamai, M. English, Delivery outcomes and patterns of morbidity and mortality for neonatal admissions in five Kenyan hospitals, *J. Trop. Pediatr.* 61 (4) (2015 Aug 1) 255–259.
- [9] Maternal and newborn health disparity, in: Ethiopia, UNICEF, 2015.
- [10] N.A. Ibrahim, A. Muhye, S. Abdulie, Prevalence of birth asphyxia and associated factors among neonates delivered in Dilchora Referral Hospital, Dire Dawa, Eastern Ethiopia, *Clin. Mother Child Health* 14 (4) (2017).
- [11] G.T. Debelew, M.F. Afework, A.W. Yalew, Determinants and causes of neonatal mortality in Jimma zone, southwest Ethiopia: a multilevel analysis of prospective follow up study, *PLoS One* 9 (9) (2014 Sep 18), e107184.
- [12] T.W. Gudayu, Proportion and factors associated with low fifth minute Apgar score among singleton newborn babies in Gondar University referral hospital; North West Ethiopia, *Afr. Health Sci.* 17 (1) (2017 May 23) 1–6.
- [13] M. Persson, S. Johansson, E. Villamor, S. Snattingius, Maternal overweight and obesity and risks of severe birth-asphyxia-related complications in term infants: a population-based cohort study in Sweden, *PLoS Med.* 11 (5) (2014 May 20), e1001648.
- [14] K. Adu-Bonsaffoh, M.Y. Ntumu, S.A. Obed, J.D. Seffah, Perinatal outcomes of hypertensive disorders in pregnancy at a tertiary hospital in Ghana, *BMC Pregnancy Childbirth* 17 (1) (2017 Dec) 1–7.
- [15] H.M. Aslam, S. Saleem, R. Afzal, U. Iqbal, S.M. Saleem, M.W. Shaikh, N. Shahid, Risk factors of birth asphyxia, *Ital. J. Pediatr.* 40 (1) (2014 Dec) 1–9.
- [16] M.F. De Almeida, M.D. Kawakami, L.M. Moreira, R.M. Dos Santos, L.M. Anchieta, R. Guinsburg, Early neonatal deaths associated with perinatal asphyxia in infants  $\geq$  2500 g in Brazil, *J. Pediatr.* 93 (6) (2017 Nov 1) 576–584.
- [17] M.A. Mohamed, H. Aly, Impact of race on male predisposition to birth asphyxia, *J. Perinatol.* 34 (6) (2014 Jun) 449–452.
- [18] A.S. Said, K.P. Manji, Risk factors and outcomes of fetal macrosomia in a tertiary centre in Tanzania: a case-control study, *BMC Pregnancy Childbirth* 16 (1) (2016 Dec) 1–8.
- [19] H. Tasew, M. Zemicheal, G. Teklay, T. Mariye, E. Ayele, Risk factors of birth asphyxia among newborns in public hospitals of Central Zone, Tigray, Ethiopia 2018, *BMC Res. Notes* 11 (1) (2018 Dec) 1–7.
- [20] L. Wosenu, A.G. Worku, D.F. Teshome, A.A. Gelagay, Determinants of birth asphyxia among live birth newborns in University of Gondar referral hospital, northwest Ethiopia: a case-control study, *PLoS One* 13 (9) (2018 Sep 7), e0203763.
- [21] Framework UW, Benishangul-Gumuz Regional State REDD+Design: A Regional Model for REDD+ under the UNFCCC Warsaw Framework, 2017.
- [22] Ethiopian Demographic Health Survey 2016, 2016.
- [23] (SARA) SAARA, Ethiopian Public Health Institute, 2018. ETHIOPIA.
- [24] Organization WH, UNICEF, Managing Complications in Pregnancy and Childbirth: a Guide for Midwives and Doctors, 2017.
- [25] Neonatal Care Protocol for Hospital Physicians, 2010.
- [26] World Health Organization, Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity, WHO/NMH/NHD/MNM/11.1, 2011.
- [27] A. Prasetyowati, The relationship between maternal anemia of a term pregnancy and neonatal asphyxia in Banda Aceh, in: Proceedings of the Annual International Conference, vol. 3, Syiah Kuala University-Life Sciences & Engineering Chapter, 2013 Nov 30. No. 1.
- [28] A.N. Kiyani, A.E. Arshad Khushdil, Perinatal factors leading to birth asphyxia among term newborns in a tertiary care hospital, Iran, *J. Pediatr.* 24 (5) (2014 Oct) 637.
- [29] B. Gane, V. Bhat, R. Rao, Antenatal and intrapartum risk factors for perinatal asphyxia: a case control study, *Curr. Pediatr. Res.* (2013).
- [30] S. Akhter, M.A. Momen, M.M. Rahman, T. Parveen, R.K. Karim, Effect of maternal anemia on fetal outcome, *Mymensingh Med. J.: MMJ* 19 (3) (2010 Jul 1) 391–398.
- [31] R. Majeed, Y. Memon, F. Majeed, N.P. Shaikh, U.D. Rajar, Risk factors of birth asphyxia, *J. Ayub Med. Coll. Abbottabad* 19 (3) (2007) 67–71.
- [32] Z. Wayessa, T. Belachew, J. Joseph, Birth asphyxia and associated factors among newborns delivered in Jimma zone public hospitals, Southwest Ethiopia: a cross-sectional study, *J. Midwifery. Reprod. Health* 6 (2) (2018 Apr 1) 1289–1295.
- [33] A.T.F. Abubakari, Z. Ali, Maternal determinants of low birth weight and neonatal asphyxia in the Upper West region of Ghana, *Midwifery* 73 (2019 Jun 1) 1–7.
- [34] K. Gross, S. Alba, T.R. Glass, J.A. Schellenberg, B. Obrist, Timing of antenatal care for adolescent and adult pregnant women in south-eastern Tanzania, *BMC Pregnancy Childbirth* 12 (1) (2012 Dec) 1–2.
- [35] R. Vasa, R. Dimitrov, S. Patel, Nuchal cord at delivery and perinatal outcomes: single-center retrospective study, with emphasis on fetal acid-base balance, *Pediatr. Neonatol.* 59 (5) (2018 Oct 1) 439–447.
- [36] D. Kaye, Antenatal and intrapartum risk factors for birth asphyxia among emergency obstetric referrals in Mulago Hospital, Kampala, Uganda, *East Afr. Med. J.* 80 (3) (2003) 140–143.
- [37] M.T. Utomo, Risk factors for birth asphyxia, *Folia Med. Indones.* 47 (4) (2011 Oct 1) 211.
- [38] Z. Abdissa, T. Awoke, T. Belayneh, Y. Tefera, Birth outcome after caesarean section among mothers who delivered by caesarean section under general and spinal anesthesia at Gondar University teaching hospital north-west Ethiopia, *J. Anesth. Clin. Res.* 4 (7) (2013) 4–8.
- [39] F. Nayeri, M. Shariat, H. Dalili, L.B. Adam, F.Z. Mehrjerdi, A. Shakeri, Perinatal risk factors for neonatal asphyxia in Vali-e-Asr hospital, Tehran-Iran, Iran, *J. Reproductive Med.* 10 (2) (2012 Mar) 137.
- [40] S. Mostari, M.R. Chowdhury, M.R. Chowdhury, D.M. Monte-Serrat, M. Mohammadnezhad, R. Kabir, Exploring the factors associated with birth asphyxia among the newborn infants at a rural hospital in Bangladesh, *Asian J. Res. Nurs. Health* (2018) 1–9.
- [41] R.M. Tshehla, M. Coetzee, P.J. Becker, Mortality and morbidity of very low-birthweight and extremely low-birthweight infants in a tertiary hospital in Tshwane, South Afr. *J. Child Health* 13 (2) (2019 Jun) 89–97.