COLLEGE OF MEDICINE AND HEALTH SCIENCE

FACULTY OF MEDICAL SCIENCE

DEPARTMENT OF ANESTHESIA

BIRTH ASPHYXIA AND ITS ASSOCIATED FACTORS AMONG NEWBORNS DELIVERED BY EMERGENCY CESAREAN SECTION IN SOUTHERN ETHIOPIA UNIVERSITY HOSPITALS: MULTI CENTER CROSS SECTIONAL STUDY.

PRINCIPAL INVESTIGATOR: SELAM TAMIRU (BSC, MSC STUDENT IN ANESTHESIS)

A THESIS TO BE SUBMITTED TO HAWASSA UNIVERSITY COLLEGE OF MEDICINE AND HEALTH SCIENCE, FACULTY OF MEDICAL SCIENCE AND DEPARTMENT OF ANESTHESIA IN PARTIAL FULFILLMENT FOR MASTER OF SCIENCE IN ADVANCED CLINICAL ANESTHESIA.

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HAWASSA, ETHIOPIA

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APPROVAL SHEET-1

This thesis entitled, "Birth asphyxia and its associated factors among newborns delivered by emergency cesarean section in southern Ethiopia university hospitals" prepared and submitted by Selam Tamiru MSc anesthesia student for partial fulfillment of a master of Science (MSc) degree in advanced clinical anesthesia has been carried out under our supervision. There for we recommend that the student has fulfilled the requirement and hence hereby can submit the thesis to the department.

Name of advisors	Signature	Date
1. Amanu Gashaw (BSc, MSc lecturer in anesthesia)	_____	_____
2. Bekele Buli (BSc, MSc lecturer in anesthesia)	_____	_____

APPROVAL SHEET-2

We, members of the Board of Examiners of the final open defense have read and examined the thesis entitled “Birth asphyxia and its associated factors among newborns delivered by emergency cesarean section in southern Ethiopia university hospitals” prepared and submitted by Selam Tamiru MSc anesthesia student for partial fulfillment of a master of Science (MSc) degree in advanced clinical anesthesia. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree.

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Internal Examiner-II	Signature	Date
_____	_____	_____
External examiner	Signature	Date
_____	_____	_____
SGS Approval	Signature	Date

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ABBREVIATION AND ACRONYM

ANC-	Ante-Natal Care
APGAR-	Appearance, Pulse, Grimace, Activity And Respiration
CPD-	Cephalo-Pelvic Disproportion
DC-	Data Collector
DURH-	Dilla University Referral Hospital
EC-	Ethiopian Calendar
GA-	General Anesthesia
GC-	Gregorian Calendar
IRB-	Institutional Review Board
IUGR-	Intra Uterine Growth Restriction
KM-	Kilo Meter
ML-	Milliliter
NRFHB-	Non Reassuring Fetal Heart Beat
PH-	Power Of Hydrogen
PI-	Principal Investigator
RA-	Regional Anesthesia
SE-	Spinal Epidural
SGS-	School Of Graduate Studies
SNNPR-	Southern Nation Nationality Peoples Regional State
WHO-	World Health Organization
WSURH-	Wolaita Sodo University Teaching Referral Hospital
WUNEH-	Wachemo University Nigist Eleni Mohammed General Hospital

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ABSTRACT

Background: Birth asphyxia is the neonate's inability to initiate or sustain spontaneous breathing. Even though improvements are being made to decrease the number of neonates being exposed, the magnitude and associated factors of birth asphyxia specifically in emergency cesarean sections have not been fully understood.

Objective: The objective of this study is to assess the prevalence and associated factors of birth asphyxia in parturients who underwent emergency cesarean section in southern Ethiopia university hospitals.

Method: A multi-center cross-sectional study was conducted among 418 parturients in 4 randomly selected university hospitals from February 7 to June 8, 2023 G.C on parturients that gave birth by emergency cesarean section. A systematic random sampling was used to collect the data using a semi-structured and pretested questionnaire from the participants and chart. The data was then encoded and entered into Epi-Data and exported to SPSS. A binary logistic regression analysis was used to identify any associated factors for birth asphyxia and variables with a P value less than 0.25 were entered into the multivariate analysis to identify independent factors. A P-value less than 0.05 was taken as significant.

Result: our study found that the overall prevalence of birth asphyxia is 28%. Antenatal visits of less than 4 AOR= 10.83, 95%CI (5.574-21.057), conventional spinal anesthesia technique AOR=5.39, 95%CI (3.043-9.58), and substance abuse AOR= 5.334, 95%CI (1.773-16.05) had a significant association with birth asphyxia.

Conclusion and recommendation: Our study showed that the prevalence of birth asphyxia in emergency cesarean section is high. Therefore, professionals must choose wisely the mode of spinal anesthesia and have a thorough history of the parturients substance use. Targeted educational programs should also focus more on maternal antenatal care awareness.

Keywords: Birth asphyxia, Emergency cesarean section, University hospitals, Ethiopia.

CHAPTER ONE: INTRODUCTION

1.1 Background

Birth asphyxia was first clearly defined in 1991 as the neonate's inability to establish breathing during birth, characterized by severe metabolic acidosis and an Apgar score of less than 4 over 5 minutes(1). It also is defined as the inability of the neonate to start or maintain spontaneous breathing at delivery(2). In developed countries, umbilical cord blood samples are used for detecting asphyxia, while in developing countries, the Apgar score is used(3-5). The Apgar score is based on five factors; a newborn's heart rate, breathing effort, muscle tone, reflex response, and appearance(6). If a newborn's score is less than 7, it is often considered an indicator of birth asphyxia(7)

It imposes greater loss among parturients with complicated pregnancies and limited delivery set-ups in developing countries (8). The changes in fetal cardiac rhythms, reduced fetal movement, and the presence of meconium-stained fluid highly indicate its presence(9, 10). The risk is particularly elevated in cesarean section, parturients with comorbidities, urgent surgical indications, and home deliveries(11). In situations where there is an immediate threat to the mother or the fetus, emergency cesarean section is an inevitable option to prevent asphyxia and its disastrous consequences(12, 13).

In Ethiopia, as well as other parts of the world, birth asphyxia is one of the most common and preventable causes of infant mortality (4). Its effect extends beyond death and includes both short and long-term neurodevelopmental squeal, such as almost incurable cognitive and motor deficits(5). According to World Health Organization guidelines, birth asphyxia is the most common cause of hypoxic-ischemic encephalopathy(HIE)(4). Cerebral palsy, multi-organ damage, and seizures (epilepsy) are also the consequences of birth asphyxia (14, 15).

Cesarean section is offered to prevent these complications, but the urgency is inherently associated with poor neonatal outcomes so parturients undergoing emergency cesarean section may be more likely to have an asphyxiated newborn(16). The attributing factors can be maternal (hemorrhage, preeclampsia) or fetal (fetal distress, cord prolapse), along with the anesthesia

given (17, 18). Although planned delivery cannot guarantee a non-asphyxiated baby, the urgency of the surgery can make cocktails of risk factors slip by unnoticed, thereby increasing the likelihood of asphyxia (19). Therefore, it is crucial to conduct research and give means to develop interventions that are specifically designed to meet the needs and realities of our community.

1.2 Statement of the Problem

Birth asphyxia is a significant public health problem globally, as it is associated with short and long-term risks and affects the outcome of the neonate(4). WHO annual report states that 4 to 9 million newborns asphyxiate every year worldwide resulting in 2 million neonatal deaths (20). In 2019 of the newborn deaths accounted for 2.4 million, birth asphyxia was the primary cause of death(5).

It occurs more frequently in low-income nations with potentially limited access to maternal and newborn care (100–250/1000 live births) than in high-income nations (5–10/1000 live births)(20). Southern Asia had a prevalence rate of 40% among deceased neonates in 2018(21). In Africa, 24% of neonatal deaths are due to birth asphyxia, while East, Central, and Southern Africa had a 22.0% incidence rate(3). The rate of perinatal asphyxia in the northern part of Ethiopia is 14.7(22). As for the eastern part, the rate is 23% (14). Additionally, birth asphyxia was the cause of neonatal mortality, 35% and 12.5%, respectively in Tigray and Gondor to determine the reasons for neonatal mortality in 2017.

Recent policies state that every country must work on keeping neonatal morbidity to at least 12 deaths per 1,000 live births. Under-developed countries like Ethiopia with up to 100 deaths per 1000 live births lack the infrastructure and materials to reach this goal and take preventive measures(4). In addition to that most mothers in rural areas tend to attempt home deliveries culturally, exposing the mother to unnecessary delay, emergent delivery and making the neonate prone to asphyxia.

The majority of the time, survivors of asphyxia typically experience long-term and short-term neurodevelopmental consequences such as ischemia, organ failure, cognitive and motor problems. Around 0.5–1/1000 full-term infants develop HIE, and 0.3/1000 have severe neurological deficits, in wealthy countries, and these numbers double for the developing sub-Saharan countries(23).

Given that the existing studies addressing this issue primarily originate from developed countries, it is improbable to suggest them as a viable solution for addressing the burden faced by low-income communities (3). The context and circumstances of the sub-Saharan countries

may differ significantly from those in developed countries, necessitating the need for tailored approaches that consider our unique challenges and resources. Studies done in different parts of Ethiopia also failed to address this matter, since most of them focus only on elective CS.

The prevention of birth asphyxia and reduction of mortality are all contingent upon the early identification and management of the underlying causes of this condition. In developing countries, efforts are being made to address these challenges by implementing infrastructure changes (5). These initiatives aim to support healthcare workers who often face resource limitations, enabling them to provide timely and effective care to mothers and infants in need (8).

While the changes being made are important steps, they alone are insufficient. There are still gaps that need to be addressed, such as improving maternal knowledge about safe delivery options, increasing the number of maternal follow-ups, and enhancing administrative support to ensure the obstetric wing is adequately equipped with both materials and manpower(24).

Prevalence studies done in low-income countries on birth asphyxia suggest that the study should be done on multiple institutions, with a larger sample size, and on emergency cesarean section with all types of surgical indications. Therefore, this study aims to assess the magnitude and associated factors of birth asphyxia among neonates delivered by emergency cesarean section by addressing the maternal, fetal, and perioperative predisposing factors.

1.3 Justification

Birth asphyxia has a significant clinical impact and long-standing challenges for newborns. Developmental delay, motor dysfunction (paralysis), and repeated hospital admissions are among the challenges that affect the quality of the child's life and parents. The evidence from different studies indicates that the prevalence of asphyxia and the urgency of cesarean section are associated notably.

Previous studies conducted on birth asphyxia in Western countries revealed that asphyxia becomes more prevalent among parturients with cesarean section. It was also noted that the magnitude and associated factors varied with the type of surgical indication, anesthesia type, maternal obesity, substance abuse, preoperative hemoglobin, and birth weight. However, most studies were not specific to emergency cesarean section and had inconsistent findings.

As far as our search covered the prevalence of birth asphyxia solely in emergency CS in Ethiopia is unknown. Even though numerous prevalence studies were done in developing and developed countries in neonates delivered by spontaneous vaginal delivery and elective cesarean section, the results and recommendations cannot be generalized for emergency cesarean sections. However, the nature of our study being multi-centered with a larger sample size makes it more suitable for generalizing the results to the broader population.

Estimation of the magnitude of asphyxia in emergency cesarean section will give a clear picture of its burden. Identifying and addressing factors associated with birth asphyxia might help professionals optimize perioperative management and improve the quality of surgical intervention for parturients.

Previous studies in this field have lacked specificity in including parturients undergoing emergency CS since they tend to mainly focus on vaginal deliveries and elective cesarean sections. Even the studies conducted with the inclusion of emergency CS have been limited to single institutions, which makes it challenging to generalize their findings. Furthermore, this study will provide baseline data for future valuable research on the topic of interest.

CHAPTER TWO: LITERATURE REVIEW

Birth asphyxia is frequently observed in neonates who experience compromised oxygenation during the birthing process. This condition occurs when there is a lack of oxygen reaching the baby's vital organs, leading to potential complications and adverse health outcomes (25).

2.1 Prevalence of Birth Asphyxia

In a study done by Ibrahim Aliyu et al on neonatal outcomes in a semi-urban setting in the United States of America where 72.9% of the mothers gave birth through emergency cesarean section, they found a 24.7% prevalence of neonatal asphyxia(26). A similar study done in China by Chen Y et al on the magnitude of both general and spinal anesthesia, revealed that the General anesthesia's group newborn asphyxia rate was 26.79% and the spinal anesthesia's group newborn asphyxia rate was 30.36% 00 (27).

A cross-sectional study done at two referral hospitals in Northern Uganda by Elizabeth Ayebare et al found that, out of 2930 mothers who gave birth to singleton neonates, only 154 neonates asphyxiated (APGAR score less than 7 at the 5th minute) giving the prevalence a 5.3%(28). In another study done in Kenya in 2018 where a total of 237 enrolled in the study, the prevalence of asphyxia was found to be 5.1%(29).

Among 1583 deliveries in the two years of retrospective data from January 2017 to January 2019 at Felegemeles Health Center in Addis Ababa, a total of 456 neonates were delivered by CS. The majority (79.8%) of the mothers had an emergency procedure and more than half of CSs were done by SA with the leading indication of NRFHB. only nine (1.9 %) neonates died and birth asphyxia was the major responsible cause of the deaths accounting for 55.5 %(30).

In a retrospective cross-sectional study done in South Gondor Zone hospitals, northwest Ethiopia in 2020, a total of 510 mother charts were reviewed and an Apgar score of less than 7 was recorded in 14.7% of the newborns in the first minute and 8.4% in the 5th minute(22). Another study done in Gondor by Alemu Degu et al concluded that, Of the 421 infants, 13.3% of them had an Apgar score below seven at the first minute, 6.7% at the fifth minute, 2.9% required intubation and 9.3% were admitted to the NICU unit(22).

2.2 Risk Factor for Asphyxia

2.2.1 Antepartum and Clinical Risk Factors

In a study done in Japan that sought to identify the associated antepartum and intra-partum causes of birth asphyxia in neonates delivered in a tertiary referral hospital, A total of 45 singleton pregnant women who gave birth to live babies at greater than 35 weeks gestation and their newborns who had birth asphyxia were included. Among the associated risk factors null parity was a significant risk factor for birth asphyxia(31).

25.3% of the 1770 cesarean sections done at the University of Cincinnati, United States during the three-year research for NRFHB, including 157 non-obese, 200 obese, and 90 severely obese women. Similar rates of neonatal deaths occurred in the non-obese, obese, and severely obese research groups: 5 (3.2%), 6, and 3 (3.3%), respectively. However, greater obesity was significantly linked to lower Apgar scores at 1 and 5 minutes. The rate of a 5-minute Apgar <6 was higher in those with morbid obesity 13 (14%) (32).

A study that enrolled 413 cases for the final analysis that was conducted at Hirosaki University Hospital of Japan, compared 287 (69.5%) mothers who received SA and 126 (30.5%) who received GA. Neonatal birth weight was among the factors that were significantly responsible for newborn asphyxia. Especially when the weight is less than 1500gm (33). Regarding the type of gestation, In a study conducted by Patchareya Nivatpumin in 2021 on mothers having multiple gestational pregnancies, twin and triplet pregnancy had a significant association with birth asphyxia, highly significant NICU admission rate, and low rate of recorded neonatal death(34).

In a study titled "Risk Factors Associated with Birth Asphyxia: A Case-Control Study" done by Syed Bilal Hassan et al, there was a substantial relation between birth asphyxia and pregnancy-induced hypertension, and females with pregnancy-induced hypertension had 4.63 times the risk of experiencing birth asphyxia. Gestational diabetes mellitus also had a significant association with birth asphyxia (AOR= 3.11, 95%CI: 1.234-7.854) (35). In another pregnancy-related coexisting disease, study conducted in 2019 by Melkamu Senbeta found that mothers with hemoglobin levels under 11 g/dl (having moderate to severe anemia) had a positive significant association with a low neonatal Apgar score(25).

In a ten-year retrospective study conducted on maternal substance abuse and neonatal outcome in Split University Hospital, Croatia, out of 5 drug dependence-complicated pregnancies 7 neonates had a 5-minute Apgar score of ≤ 7 (8%)(36). As for another maternal issue which is antenatal care, a case-control study done in Benshangul Gumuz Ethiopia compared newborns whose mothers had at least four ante-natal care (ANC) visits vs. no ANC visit, the risk of birth asphyxia was shown to be 4.2 times higher in newborns whose mothers had no ANC visits at all, 15.6% vs 56% (25).

2.2.2 Surgical-related Risk Factors

In a retrospective cohort study by Clare Newton et al done in India, the neonatal outcomes of cord prolapse and placental abruption were shown to be significantly poorer, with the former being related to a lower mean arterial cord pH of 0.2 while the latter was associated with low 5th minute Apgar score(37).

In a one-year retrospective study done by Attah Raphael et al, a total of 2999 births were recorded during the one-year study period. There was a statistically significant link between the need for a cesarean section and the occurrence of a poor perinatal outcome. It was observed in all cases of uterine rupture, 50% of cases of placenta previa and significant bleeding, 40% of cases of abruption placenta with a live baby, and 37.5% of cases of cord prolapse(38).

A study conducted in 2020 by Temesgen et al found that Fetal distress (52.15%), prior C/S scars with active labor (9.82%), and cephalo-pelvic malformation (9.20%) were the most common reasons for emergency C/S with decreased 1st and 5th minute Apgar score. An imminent uterine rupture, a prolapsed umbilical cord, a placenta previa, and severe pre-eclampsia are some more possible indications without significant associations of neonatal asphyxia(16).

In a study done in public health facilities of Arba Minch town, severe preeclampsia/eclampsia was the leading indication for cesarean section with significant association with newborn asphyxia (39). In a study conducted by Degu ayele, non-reassuring fetal heart rate patterns (24.1%) and cephalo-pelvic disproportionate (CPD) (15.7%) were the main causes of emergency C/S with high prevalence for birth asphyxia, followed by failed induction (15.3%) and prolapsed umbilical cord (22).

In a study done in southern Ethiopia in 2023, only 114 (21.3%) parturients achieved a decision-to-delivery interval within 30 minutes out of the total study participants. According to the study's findings, there was no statistically significant correlation between a longer decision-to-delivery period (>30 minutes) and NICU admission, infant death before discharge, stillbirth, or low Apgar scores at the 1st and 5th minutes of life(40). Regarding the incision-to-delivery time, a study done in Bangkok, Thailand, Found a significantly shorter incision-to-delivery time in the general anesthesia group than in spinal anesthesia. Contrarily, 1 and 5-minute Apgar scores were significantly decreased in the GA group than in SA(34).

2.2.3 Anesthesia-related Risk Factors

In a retrospective cross-sectional study done at Phuentsholing General Hospital (2020), mothers who had longer exposure to induction to delivery time of anesthesia had neonates with poor Apgar scores. Even though there was no statistically significant association, it increased the decision to delivery interval and exposed neonates to decreased Apgar score(41).

A 5-year retrospective cohort study conducted by E palmer et al concluded that the anesthesia technique of GA was independently associated with lower 5-minute Apgar scores, unlike SA which did not have any significant effect(42).In a similar study done to assess neonatal outcomes after cesarean delivery in 2013, newborns delivered by spinal anesthesia were 3 times less likely to have a low 5th-minute Apgar score when compared to those newborns delivered under general anesthesia(43).

A retrospective matched case–control study that was conducted at Siriraj Hospital Bangkok, compared the effect of failed spinal and single shot spinal. While the failed spinal anesthetic group had a larger percentage of newborns experiencing asphyxia at delivery, the difference was not statistically significant(44). Concerning the spinal anesthesia drugs, in a study conducted by Bishwas Pradhan comparing, 5% lignocaine with 0.5% bupivacaine for cesarean section the maximum effect was attained in 3 minutes for lignocaine and 8 minutes for bupivacaine. At one minute and five minutes, all of the neonates had average APGAR scores of 7 and 8.5 in the lignocaine group and 7.3 and 8.9 in the bupivacaine group(45).

In a study done in Punjab India, significant tachycardia was observed in patients undergoing hyperbaric bupivacaine, which can be attributable to a reflex increase brought on by the

accompanying instability. Even though there was no significant association between the hemodynamic instability and neonatal Apgar score of 1 and 5 minutes (46). In a study done by Malak Sarkay comparing preloading with co-loading for emergency CS, the study did not identify any differences between the preload and co-load groups in neonatal outcomes at 5 minutes but it did show differences between the neonatal outcomes at 1 minute Apgar. Preloaded groups had a significantly higher percentage of infants with a 1-minute Apgar score below 7 than the co-loaded groups(47).

A study done at Gondor University which is a prospective cohort study found that among mothers who emergently took spinal anesthesia by BSc students, 80% of them had a repeated attempt at spinal anesthesia needle insertion and prolonged induction to delivery time which had negative fetal outcomes (22).

2.3 Conceptual Framework for factors associated with birth asphyxia

([22](), [25](), [27](), [30](), [32](), [35](), [37](), [39](), [44](), [48-50]())

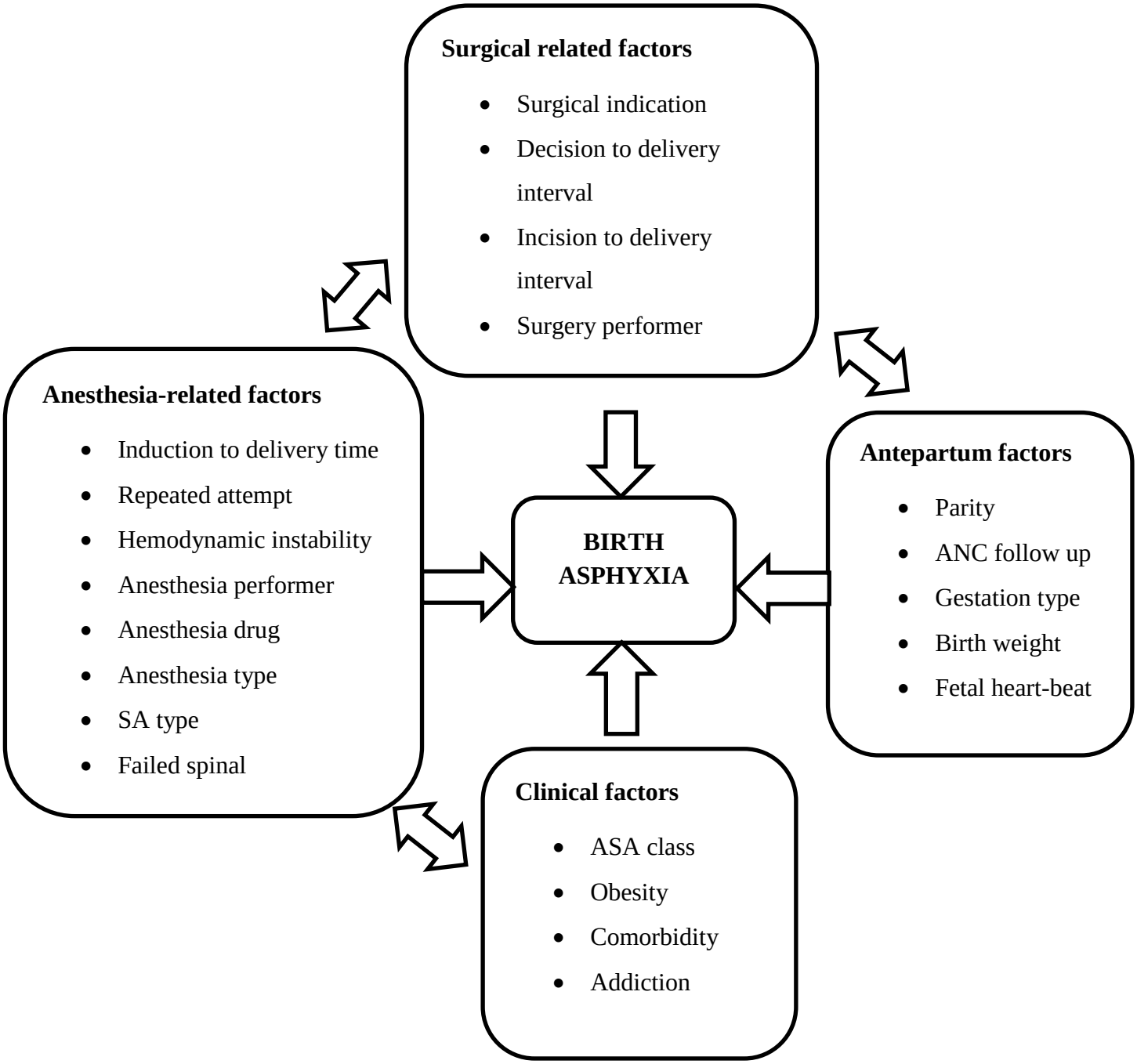

Figure 1: Conceptual Framework

CHAPTER THREE: OBJECTIVE

3.1 General Objective

To assess the prevalence and associated factors of birth asphyxia among newborns delivered by emergency cesarean section in southern Ethiopia university hospitals from February 7 to June 8 2023 G.C.

3.1.1 Specific Objective

1. To determine the prevalence of birth asphyxia in emergency cesarean section in southern Ethiopia university hospitals.
2. To identify the associated factors of birth asphyxia in emergency cesarean section in southern Ethiopia university hospitals.

CHAPTER FOUR: METHODOLOGY

4.1 Study Area and Period

The study is conducted in southern Ethiopia's randomly selected (with lottery method) 4 university hospitals from February 8 to June 7, 2023, G.C (yekatit 1 to gimbot 30 2015 E.C). Hawassa University Comprehensive Specialized Hospital (HUCSH), Wolaita Sodo University Teaching Referral Hospital, Dilla University Referral Hospital and Wachemo University Nigist Eleni Mohammed memorial comprehensive specialized comprehensive Hospital were the selected sites.

HUCSH is located 273km south of Addis Ababa city and it is one of the biggest government hospitals in Ethiopia serving as a teaching and regional referral hospital since 2005E.C(51). It has about 10 operation tables including two obstetrics and two Ophthalmologic operations (48). Wolaita Sodo University Teaching Referral Hospital (WSURH) is located in Sodo Town, with a settlement of 380 kilometers south of Addis Ababa. It offers a wide range of medical services to both in and out-patients of all ages in its roughly two million-person catchment area(52).

365 kilometers south of Addis Ababa, Gedio zone, SNNPR in the town of Dilla, sits the Dilla University Referral Hospital (DURH). It provides clinical treatment to the community as well as instructional services for students (53). Wachemo University Nigist Eleni Mohammed Memorial Comprehensive Specialized Hospital (WUNEH) is located in Hosanna town in the northern part of SNNPR, 232 km from Addis Ababa. Offers both preventive and curative health care services for more than 2 million residents(54).

4.2 Study Design

Multicenter cross-sectional study

4.3 Study Population

4.3.1 Source Population

All newborns delivered by emergency cesarean section at the selected southern Ethiopia university hospitals.

4.3.2 Study Population

Randomly selected newborns delivered by emergency cesarean section at the selected southern Ethiopia university hospitals during the study period.

4.4 Eligibility Criteria

4.4.1 Inclusion Criteria

All live newborns delivered by emergency cesarean section at the selected southern Ethiopia university hospitals.

4.4.2 Exclusion Criteria

- Psychiatric patients
- Uterine rupture before decision
- Severe congenital malformation
- Preterm neonates

4.5 Study Variable

4.5.1 Dependent Variable

- Birth asphyxia

4.5.2 Independent Variable

- Socio-demographic data (age, residence, educational status)
- Clinical characteristics (ASA classification, comorbidities, substance abuse, obesity)
- Antepartum
    - ANC follow up
    - Parity
    - Type of gestation
    - Birth weight
    - Fetal heart-beat
- Surgical-related factors
    - Surgical indication

        - Maternal-related (preeclampsia, CS scar in labor, failed induction, CPD, APH)
        - Fetal-related (NRFHB, meconium aspiration, cord prolapse, breach)
    - Decision to delivery time
    - Incision to delivery time
    - Surgery performer
- Anesthesia-related factors
    - Anesthesia type
    - Failed spinal
    - Anesthesia performer
    - Repeated attempt
    - Induction to delivery time
    - Anesthesia drug choice
    - Type of SA
    - Hemodynamic instability

4.6 Sample Size and Sampling Procedure

4.6.1 Sample Size Determination

The sample size was calculated by using a single proportion formula. Confidence interval of 95% and a margin of error of 0.05, the expected prevalence was 55.5% which was taken from a previous study done in Addis Ababa, Ethiopia(30).

$n = \frac{z2p(1-p)}{d2}$; Where; n= sample size; Z = statistics for 95% confidence interval (1.96); P = prevalence; d = margin of sampling error to be tolerated (0.05).

n= $\frac{(1.96)^2 \times 0.55(1-0.55)}{(0.05)^2}$ = 380.3 and 10% of additional sample is included by assuming non-respondent rate 379.5×10%= 38.03

n=380.3+38

n=418

A situational analysis was done based on a Recorded logbook of obstetrics surgery for the consecutive same three months of last year in each university hospital. According to this, 414 neonates were delivered by emergency cesarean section in HUCSH, 199 in DURH, 120 in WSURH, and 100 in WUNEH. 832 neonates have been delivered by emergency cesarean section on average at these hospitals.

Finally, the sample size was allocated proportionally to all hospitals based on their average three months report. So, a total of 832 delivered neonates by emergency CS. Since the calculated sample size was 418; 832 divided by 418 is 1.99: HUCSH= 414/1.99= 208, DURH= 199/1.99= 100, WSURH= 120/1.99= 60 and WUNEH= 100/1.99=50

4.6.2 Sampling Procedure

Four study areas were randomly selected with a lottery method from six Southern Ethiopia governmental teaching hospitals. The selection of participants was carried out with a systematic random sampling technique. By using systematic random sampling the k value (k=N/n, 832/418 =1.99 ≈2), where N = number of newborns in the last three months, n = sample size, k = interval. Of the first two neonates, one was selected through a lottery method to be the study participant.

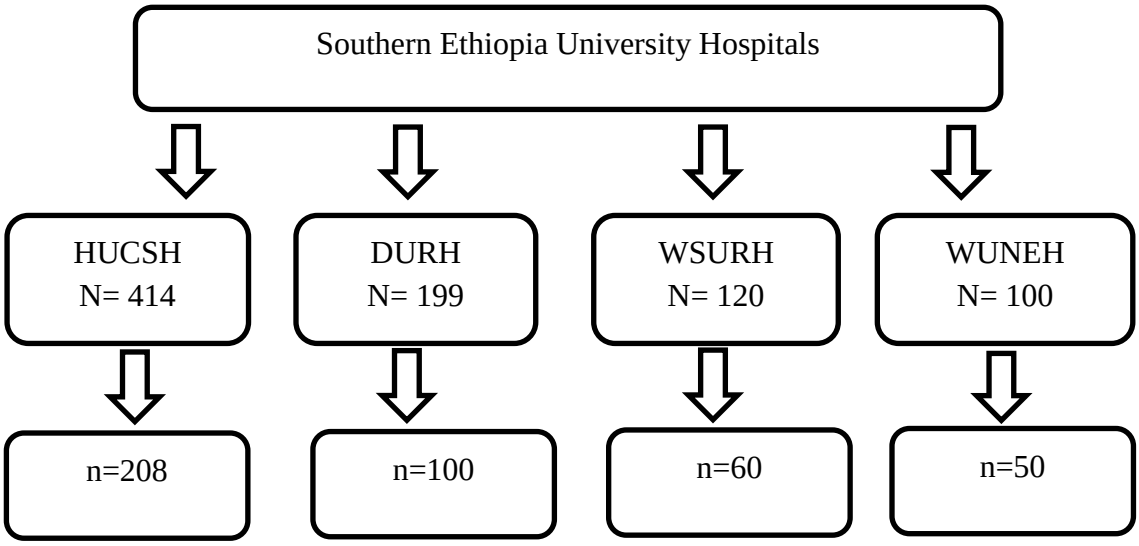

Figure 2: Proportional allocation for sample size

4.7 Data Collection Procedure

Data was collected by a semi-structured questionnaire (adapted from previous related studies(16, 39, 44, 52, 55)) from both mothers who underwent cesarean section and their medical chart. Information about the study benefits, harm, and objective of the study was prepared in English and then translated to Amharic, and was explained to the study participants intra-operatively. 8 trained data collectors and 4 supervisors were involved in the data collection process. Written informed consent was obtained before anesthesia from the mother or her family. The birth asphyxia determinant was the Apgar score (<7 Apgar= presence of birth asphyxia and >7 = absence of birth asphyxia), which was not explained to the investigator and data collectors. To limit their involvement in the interpretation of the Apgar score in all four sites for the sake of bias minimization.

4.8 Data Quality Management

To assure the quality of data, one-day training on the objectives and relevance of the study and a brief orientation on the assessment tools were provided for data collectors before data collection was begun. To ensure the quality of the data, a pretest was done at Bule Hora University Teaching Hospital and the data collection tool (questionnaire) was tested on 5% of the total sample size. The Cronbach's alpha value was 0.83 (83%).

Based on the pre-test findings, syntax, sequencing, and timing were adjusted before the real data collecting started. Each questionnaire was revised by the investigators for being complete and appropriate for all study participants. The data collectors were instructed to write card numbers on the questionnaire during the data collection if further cross-checking is needed. The complete data was encoded and entered into Epi-Data version 4.6 and exported to SPSS version 26 for analysis.

4.9 Data Processing and Analysis Procedure

Data was analyzed by using SPSS version 26 software packages. The data analysis was carried out using both descriptive and inferential statistics, describing categorical variables as frequencies and percentages.

Binary logistic regression analysis was conducted to identify any associated factors for birth asphyxia. Only variables that showed an association with birth asphyxia in bivariate analysis (p-value <0.25) were entered into a multivariable logistic regression model to identify birth asphyxia's independent factor. A backward stepwise elimination technique was used to build the logistic regression model. The model fitness was evaluated using the Hosmer-Lemeshow goodness of fit test. The variance inflation factor (VIF) test was used to assess the explanatory variables for multi-collinearity before entering the multivariable model and three variables with a VIF value of >10 were omitted from the logistic regression analysis. A P-value less than 0.05 was taken as statistically significant.

4.10 Ethical Approval

Support letter and ethical clearance were received from the institutional review board (IRB) of Hawassa University College of Medicine and Health Science before the start of the study. The advantage and risk of the study was explained and written informed consent was obtained from each study participant or family voluntarily by the data collectors. Discretion was kept during the study by avoiding credentials and using codes to identify patients. All ethics committees or IRB will revise informed consent and materials given to the participant.

4.11 Dissemination Plan

Copies of the final result will be submitted to the Department of Anesthesia, Department of Gynecology, and Community-based education office. Efforts will also be made to present at annual research conferences like maternal newborn and child health conferences and regional conferences. It will be sent to local and international high-impact reputable journals for publication.

4.12 Operational Definition

Birth asphyxia: a neonate with an Apgar score of less than 7 in the first minute (56).

Decision to delivery time: Time from deciding to do a cesarean section to delivering the fetus.

Induction to delivery time: Time from delivering the anesthesia to delivering the fetus.

Incision to delivery time: Time from the start of surgical incision to delivery of the fetus.

CHAPTER FIVE: RESULT

5.1 Socio-Demographic and Perioperative Characteristics of the Parturients

A total of 418 parturients who delivered with emergency cesarean section were enrolled in this study without a non-response rate. The majority of the parturients were in the age range of 20 to 34, with minimum and maximum ages being 18 and 48 respectively. 23.2% of them were obese while 55% were overweight. Most parturients are literate, have urban residence, and have term gestational age.

Table 1: Socio-demographic characteristics of parturients at the selected southern Ethiopia university hospitals, February to June 2023(n=418)

Variable	Category	Frequency (%) (n=418)	Asphyxia	
			Yes	No
Mothers age	<20	15(3.6)	3(20)	12(80)
	20-34	364(87.1)	101(27.7)	263(72.3)
	35-49	39(9.3)	13(33.3)	26(66.7)
Residence	Urban	323(77.3)	65(20.1)	258(79.9)
	Rural	95(22.7)	52(54.7)	43(45.3)
Educational status	Literate	302(72.2)	46(15.2)	256(84.8)
	Illiterate	116(27.8)	71(61.2)	45(38.8)
BMI	normal	91(21.8)	6(6.6)	85(93.4)
	Overweight	230(55.0)	34(14.8)	196(85.2)
	Obese	97(23.2)	77(79.4)	20(20.6)
Gestational age	Term	365(87.3)	97(26.5)	268(73.4)
	Post-term	53(12.7)	20(37.7)	33(62.2)

In the present study, the majority of the parturients were ASA II (76.8%) and multi-para (62.2%). Mothers with presumed adequate ANC follow-up were 78.3%, and parturients with substance abuse were 8.1% of which alcohol consumers were 64.7% and chat chewers were 35.3% (Table 2).

In terms of preoperative health status, 14.1% of the study participants had a history of comorbid conditions, of which hypertension takes the highest rank (6.9%) followed by anemia (5.7%) while diabetes mellitus and valvular heart disease are the least comorbidities with 0.2% each.

Table 2: Preoperative baseline characteristics of parturients at the selected Southern Ethiopia University hospital, February to June 2023(n=418)

Variables	**Category**	**Frequency (%) n=418**	**Asphyxia**	
			Yes	**No**
Parity	Null para	160(38.3)	66(41.3)	94(58.7)
	Multi-para	258(61.7)	51(19.8)	207(80.2)
ANC follow up	<3	87(19.9)	68(78.2)	19(21.8)
	4-8	331(80.1)	49(14.8)	282(85.2)
Comorbidity	None	359(85.9)	69(19.2)	290(80.8)
	hypertension	29(6.9)	20(68.9)	9(31.1)
	Anemia	24(5.7)	22(91.7)	2(8.3)
	Others	6(1.4)	6(100)	0(0)
Gestation type	Single	395(94.5)	107(27.1)	288(72.9)
	Multiple	23(5.5)	10(43.5)	13(56.5)
Substance abuse	Yes	34(8.1)	27(79.4)	7(20.6)
	No	384(91.9)	90(23.4)	294(76.6)

ASA class	II	321(76.8)	25(7.8)	296(92.2)
	III and above	97(23.2)	5(5.2)	92(94.8)

Others: acute kidney injury, diabetes mellitus, thyrotoxicosis, and valvular heart disease.

Out of the 418 cesarean section deliveries, 109(26.1%) of the parturients had non-reassuring fetal heartbeat indication, which is the highest surgical indication. The second highest surgical indication is parturient with previous CS scar in labor with 104(24.9%) followed by meconium aspiration with 45 (10.8%).

The total time that took the parturients to deliver the baby starting from the time of the decision was divided into less than forty minutes, which has a total of 149(35.6%) and greater than forty minutes with a total of 269(64.4%). Parturients with a decision to delivery time of <40 minutes had 2.1% asphyxiated newborns whereas 42.3% asphyxiated babies were among the deliveries with a>40 minutes decision to delivery time (table 3).

Table 3: Perioperative condition of parturients who underwent emergency cesarean section at the selected Southern Ethiopia University hospital, February to June 2023 (n=418)

Variable	**Category**	**Frequency (%)**	**Asphyxia (n=418)**	
			Yes	**No**
Anesthesia Type	Spinal anesthesia	405(96.9)	106(26.2)	299(73.8)
	General anesthesia	13(3.1)	11(84.6)	2(15.4)
Change in MAP	Yes	79(18.9)	52(65.8)	27(34.2)
	No	339(81.1)	65(19.2)	274(80.8)
Surgical indication	Maternal	263(62.9)	73(27.8)	190(72.2)
	Fetal	155(37.1)	44(28.4)	111(71.6)
Induction to incision	≤ 10 minutes	149(35.6)	69(18.75)	299(81.75)

	>10 minutes	269(64.4)	48(96)	2(4)
Incision to delivery	≤ 5 minutes	298(71.3)	6(2.1)	292(97.9)
	>5 minutes	120(28.7)	111(92.5)	9(7.5)
Decision to delivery	≤40 minutes	149(35.6)	3(2.1)	146(97.9)
	>40 minutes	269(64.4)	114(42.3)	155(57.7)

Maternal indication (preeclampsia, CS scar in labor, failed induction, CPD, APH); Fetal indication (NRFHB, meconium aspiration, cord prolapse, breach).

5.2 Prevalence of Birth Asphyxia

In the present study, the Prevalence of birth asphyxia among newborns delivered via emergency cesarean section is 28 percent (figure 5) with 50.5% of them being male and 49.5% of them being female. In terms of severity, out of 28% of the asphyxiated neonates, 2.6% had severe asphyxia while the rest had moderate asphyxia.

9.4% of the asphyxiated neonate parturients were given general anesthesia, while the rest 90.6% took spinal anesthesia. 52.99% of the procedures, where there was birth asphyxia, were done with year 3 residents. The educational status of the parturients with asphyxiated neonates inclines toward illiteracy at 60.68%.

In addition, of the 109 parturients with non-reassuring fetal heartbeat, 29(26.6%) developed birth asphyxia. As for previous CS scar in labor indication, 14(13.46%) of them developed asphyxia while meconium aspiration had 11(24.4%) and breach presentation had 12 (30.7%) asphyxia rates. Placental abruption is the least cesarean section surgical indication with 3(0.7%) of which 2(66.6%) of the neonate asphyxiated.

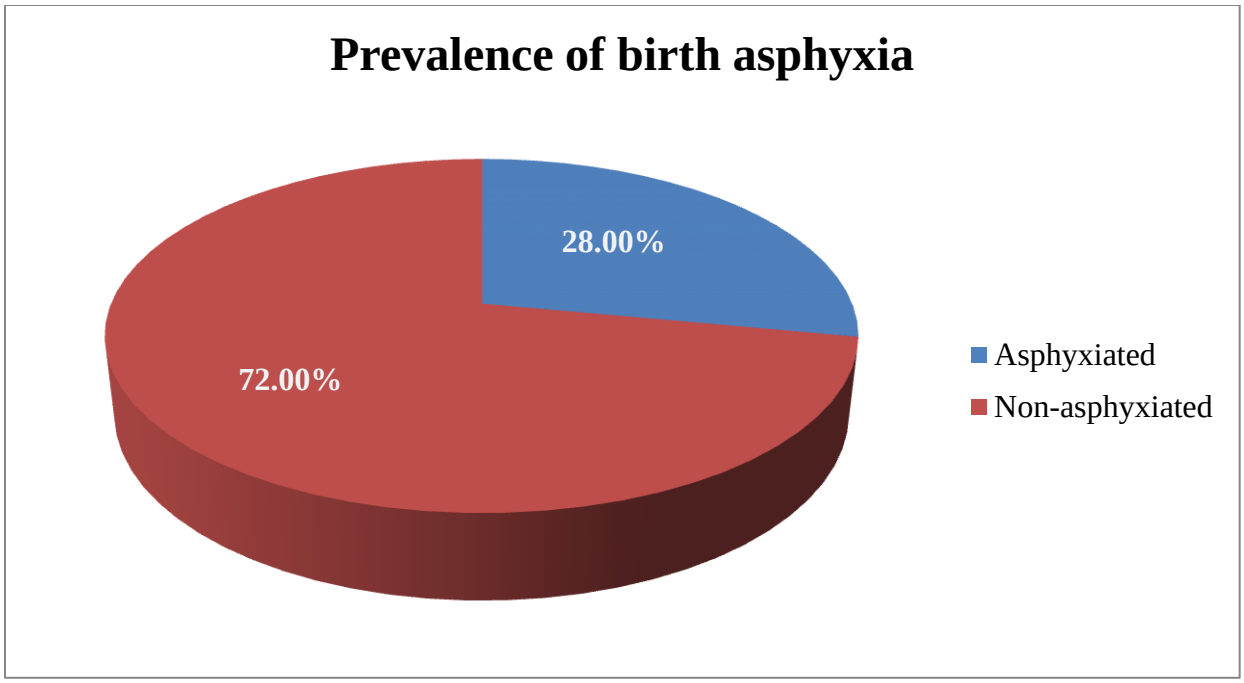

Figure 3: Prevalence of birth asphyxia among newborns delivered by emergency cesarean section at the selected southern Ethiopia university hospitals, 2023 (n=418)

5.3 Factors Associated with Birth Asphyxia

The bivariate logistic regression was fitted to identify the factors associated with birth asphyxia. Accordingly, ASA, substance abuse, ANC follow-up, decision to delivery, induction to delivery, type of spinal anesthesia, surgical indication, and anesthesia performer showed association with birth asphyxia at a P value of <0.25.

Table 4: Bivariate logistic regression of factors associated with birth asphyxia among newborns delivered by emergency cesarean section at the selected southern Etiopia University teaching hospitals from February to June 2023 (n=418)

Variable	Category	COR (CI)	P-value
Type of spinal anesthesia	Conventional	7.476 (4.576-12.215)	**0.000**
	Rapid sequence	1	
Parity	Null para	1	0.286

	Multi para	2.85 (1.83-4.42)	
Substance abuse	Yes	12.60 (5.310-29.90)	**0.000**
	No	1	
ASA	II	1	**0.000**
	III and above	0.005(0.002-0.012)	
Anesthesia performer	Professional	1	**0.21**
	Student	24.64 (10.41-60.91)	
Decision to delivery	≤40 minutes	1	**0.367**
	>40 minutes	0.028(0.010-0.342)	
Induction to delivery	≤10 minutes	1	**0.000**
	>10 minutes	0.009(0.003-0.012)	
Change in MAP	Yes	8.12(4.861-17.335)	0.411
	No	1	
Anesthesia type	General anesthesia	0.065 (0.009-0.162)	0.908
	Spinal anesthesia	1	
Surgical indication	Maternal	0.969 (0.201-0.999)	**0.145**
	Fetal	1	
ANC follow up	<4	20.59 (11.39-37.23)	**0.000**
	4-8	1	

As shown in Table 5, anesthesia type, null parity, and hemodynamic instability (change in MAP) did not show an association with birth asphyxia. In addition to the aforementioned independent factors, obesity, anesthesia drug, incision to delivery interval, birth weight, and gestation type had p-values>0.25 so were not included in the multivariable analysis.

Table 5: A multivariable logistic regression analysis showing factors associated with birth asphyxia among newborns delivered by emergency cesarean section at the selected southern Ethiopia university hospitals, February to June 2023 (n=418)

Variable	Category	Asphyxia n=418		COR(CI)	AOR(CI)	p-value
		Yes	No			
Type of spinal anesthesia	Conventional	72	66	7.476 (4.576-12.21)	5.39(3.043-9.58)	0.000**
	Rapid sequence	34	233	1	1	
ANC follow up	<4	68	19	20.59 (11.39-37.23)	10.83 (5.574-21.057)	0.000**
	4-8	49	282	1	1	
Substance abuse	Yes	27	7	12.60 (5.310-29.90)	5.334(1.773-16.05)	0.003*
	No	90	294	1	1	

Key: **: Highly significant in the Multivariate logistic regression (p-value < 0.001), AOR adjusted odds ratio, COR crude odds ratio, CI confidence interval.

CHAPTER SIX: DISCUSSION

Birth asphyxia becomes more common as parturients are emergently rushed to deliver the newborn, due to time sensitivity, and limited maternal knowledge. The present study was conducted to determine the magnitude and associated factors of birth asphyxia among mothers who underwent emergency cesarean section.

6.1 Prevalence of Birth Asphyxia

This multicenter cross-sectional study revealed that the Prevalence of birth asphyxia among parturients who underwent emergency cesarean section was 28% (95%CI 23.7-32.1%) which is comparable with the study done by Ibrahim Aliyu et al in the United States (24.7%)(26), Chen Yi et al in China (26.79%)(27), Melkamu Set al Western Ethiopia (25.09)(25) and Mohammed S et al in Addis Ababa Ethiopia (30.2%)(55).

On the other hand, our finding is higher than a study conducted in Uganda by Elizabeth Ayebare et al, who reported an asphyxia prevalence of 5.3%(57). The observed discrepancy in findings could potentially be attributed to differences in exclusion criteria between the studies, in which the study excluded parturients with critical illness and parturients with multiple gestations, which could have influenced the outcome. In a study done in Kenya, the prevalence of asphyxia was found to be 5.1% which was in contrast with our study(29). The observed difference might be due to the sample size. In their study, the participant's sample size was 237, whereas our sample size was 418.

Another discrepancy was noticed between our study and a study done by Rajkumar M et al(58), which found a magnitude of 17.3%. This result is lower than our studies finding which might be due to the difference in operational definition of birth asphyxia. Our study took an Apgar score of 1 minute whereas they took an Apgar score of 5 minutes to determine the presence of birth asphyxia. Our study was not also consistent with a study done in northwest Ethiopia with a prevalence of 14.7%(22). The disparity between the two studies could be attributed to several factors. Firstly, the nature of their study being retrospective might have limitations that affected the results. Additionally, the selection of only primary hospitals in their study, excluding referral cases and parturients with comorbidities, could have influenced the observed magnitude.

The principal indications for emergency CS in our study were non-reassuring fetal heart rate patterns (16.6%), which is comparable to the study done in north-west Ethiopia (24.1%). In their study, cephalo-pelvic disproportion takes second place (15.7%), but in our study preeclampsia/eclampsia comes second (15.5%), and this discrepancy in findings could potentially be attributed to the exclusion of gestational hypertension in their study. (22). Severe antepartum hemorrhage has 7.6% in our study, which is in line with a study conducted in Bhutan, southern Asia (8%)(41).

6.2 Factors Associated with Birth Asphyxia

In our study, a significant association between parturient ANC follow-up and birth asphyxia was found. Newborns of parturients with inadequate ANC follow-up, which is ANC follow-up of less than four throughout their pregnancy were 10.8 times more likely to develop birth asphyxia than newborns of parturients with adequate ANC follow-up (4-8ANC follow-up) throughout their pregnancy[AOR=10.83, 95%CI: (5.574-21.05)]. This finding is consistent with the study done in Benshangul Gumuz northwest Ethiopia (25) and a study done in Togo(59).

This study shows no significant association between type of anesthesia (whether it is general or regional) and birth asphyxia, Even though the study done in Bangkok(34) found a positive significant association between general anesthesia and 1-minute Apgar score. The discrepancy might be due to the difference between the study participant in their study who took general anesthesia (n=73(6.9%)) and our study participant who took general anesthesia (n=13(3.1)). The study participants were also parturients with multiple gestations whereas in our study parturients with multiple gestations were only 5%. However, our study is in line with the finding of Yi Chen et al from China which found no significant association between the two techniques (27).

From perioperative-related factors, the type of spinal anesthesia is significantly associated with birth asphyxia. This study revealed that parturients who took the conventional type of spinal anesthesia were 5.39 times more likely to have asphyxiated newborns than parturients who took rapid sequence spinal anesthesia [AOR=5.39, 95%CI: (3.043-9.580)]. A study done in Bengal, India(47) and a study done in Bangladesh(60) both found a significant association between fluid preloading (conventional type of spinal anesthesia) and poor neonatal outcomes. This finding is in line with our study.

Our study did not uncover any significant association between obesity and birth asphyxia, despite the study done by Emily T et al(32) and a study done in Sweden(61). The study found a significant association between >30kg/m^2 BMI (obese and morbidly obese). This discrepancy might be due to the variation in genetic makeup and the substantial difference between the socio-economic status of the developed and developing countries. Most of their study participants were in class II and above obesity classifications, whereas most of our study participants were in the overweight group of the classification.

From maternal clinical characteristics, our study found maternal substance abuse to be an independent factor for birth asphyxia. In this study, addicted parturients were 5.33 times more likely to develop birth asphyxia than parturients with no history of substance abuse [AOR=5.33, 95%CI: (1.773-16.051)]. While the substance they were using was alcohol and chat, this finding is in line with, a Croatian study(36), a Thai study(62), and a study done in Iran(63) which found a significant association between maternal addiction and a neonatal Apgar score of less than 7.

6.3 Strength of the Study

The first strength is our study takes place in four different university hospitals in southern Ethiopia, which increases its generalizability. Second, we used a systematic sampling method which, helps minimize bias.

6.4 Limitations of the Study

The potential drawback of our study is the nature of our study being cross-sectional, which limited us from following the 5^{th} and 10^{th}-minute Apgar score of the neonates which might have given us follow-up time to assess further outcomes.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATION

7.1 Conclusion

The prevalence of birth asphyxia is found to be higher in relation to the previous studies. Among the studied factors of birth asphyxia, inadequate ANC follow-up, conventional type of spinal anesthesia technique, and maternal substance abuse were identified as significantly associating factors for birth asphyxia in emergency cesarean section. Based on the present study, the factors associated with birth asphyxia were preventable.

7.2 Recommendation

Depending on our studies finding, we recommend the following:

1. Clinicians

Our findings indicate that the choice of spinal anesthesia is associated with a higher prevalence of birth asphyxia. As a result, it is crucial to choose the type of the spinal anesthesia during urgent deliveries.

2. Policymakers

Our study also showed low ANC follow-up to be the main factor increasing the Prevalence of birth asphyxia. So, policymakers should prioritize addressing the issue of antenatal care programs among parturients, through targeted educational programs and initiatives that aim to enhance the knowledge and understanding of pregnant women.

3. Researchers

There is a need for further similar studies in other areas since there is not enough information about the magnitude of birth asphyxia in emergency cesarean section in Ethiopia. Researchers are also encouraged to investigate other studies in the general population that help to identify the burden of birth asphyxia in emergency cesarean section by identifying gaps and addressing the limitations of this study.

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ANNEX 1: Data Collection Tool

Identification

Name of the Institute _____Address of the Institute _____

Hello greeting, I am _____.

I am working with the research team with a title of "BIRTH ASPHYXIA AND ITS ASSOCIATED FACTORS AMONG NEWBORNS DELIVERED BY EMERGENCY CESAREAN SECTION IN SOUTHERN ETHIOPIA UNIVERSITY HOSPITALS" for the fulfilment of Master of Science in Department of Anaesthesia, College of Health Science and Medicine, Hawassa University. So I would like to ask you some questions relevant to the study which may take about 15 minutes at different times.

The purpose of this questionnaire is to gather information about the study aimed to assess the magnitude and associated factors of birth asphyxia in emergency cesarean section in southern Ethiopia governmental teaching hospitals. Your response to the study items will highly contribute to the success of the study. You will be asked by data collectors and some data will be taken from your chart. Your name, your responses, or anything describing you will not be mentioned to anyone. Everything will be confidential in a secure way; you will have the full right to refuse not to participate in the research. You will not be given any incentives or be benefited or injured in any way. The information will be used for the intended purpose only.

በመረጃ የተደገፈ የስምምነት ቅጽ

የኢንስቲትዩቱ ስም _____

የተቋሙ አድራሻ _____

ጤና ይስጥልኝ ሰላም፣ እኔ _____
ነኝ።

በ ሀዋሳ ዩኒቨርሲቲ የጤና ሳይንስ እና ህክምና ኮሌጅ የአንስቴዢያ ትምህርት ክፍል ማስተር ኦፍ ሳይንስን ለማሟላት በድንገተኛ ቀዶ ህክምና የተወለዱ ጨቅላ ህጻናት መታፈን ብዛትና ተያያዥ መንስኤዎቻቸው ዙሪያ ምርምር ለማድረግ በሚሰራው ቡድን ውስጥ ተሳታፊ ነኝ። ስለዚህ ከጥናቱ ጋር የተያያዙ አንዳንድ ጥያቄዎችን ልጠይቅዎት እፈልጋለሁ ይህም በተለያዩ ጊዜያት 15 ደቂቃ ሊወስድ ይችላል።

የዚህ መጠይቅ ዓላማ በድንገተኛ ቀዶ ህክምና የወለዱ እናቶች እና የጨቅላ ህጻን መታፈን መካከል ያለውን ግንኙነት እና ተያያዥ ምክንያቶችን ለመገምገም መረጃ መሰብሰብ ነው። ለጥናት የሚሰጡት ምላሽ ለጥናቱ ስኬት ከፍተኛ አስተዋፅኦ ይኖረዋል። በመረጃ ሰብሳቢዎች ይጠየቃሉ እና አንዳንድ መረጃዎች ከገበታዎ (chart) ይወሰዳሉ። ስምዎ ፣ ምላሾችዎ ወይም እርስዎን የሚገልጽ ማንኛውም ነገር ለማንም አይጠቀስም። ሁሉም ነገር በአስተማማኝ መንገድ ሚስጥራዊ ይሆናል; በጥናቱ ውስጥ ላለመሳተፍ ሙሉ መብት ይኖርዎታል። በምርምሩ ዉስጥ ባልመሳተፍዎ የሚያጡት ወይም የተለየ የሚያገኙት ምንም ነገር የለም ወይም እንዲሳተፉ ምንም አይነት ማበረታቻ አይሰጥዎትም። መረጃው ለታለመለት ዓላማ ብቻ ጥቅም ላይ ይውላል።

Data collection tool for the factors associated with birth asphyxia among newborns delivered by emergency cesarean section in selected university hospitals of southern Ethiopia in 2023

Section 1: Parturients socio-demographic characteristics

Serial No	Questions	Possible Response	Code
101	Mother's age (in years)		
102	Educational status		
103	Weight/height (BMI)		
104	Residence	1 urban 2 rural	
105	Occupational status	1 gov.t worker 2 non-gov.t workers 3 house-wife	
106	Comorbidities (HTN, DM…)	1 HTN 2 DM 3 others	
107	ANC follow up	_____	
108	parity	1 null-para 2 multi para	
109	Substance abuse	1 tobacco 2 alcohol 3 illegal drugs	
110	ASA	1 1 2 2 3 3 4 4	
111	Gestation type	1 single 2 multiple	
112	Pre-operative CBC	1 hgb____ 2 hct_____ 3 plt_____	
113	Surgical indication	1 NRFHB 2 Cord prolapse 3 Breach 4 Abruption 5 Severe APH 6 Eclampsia 7 cephalo-pelvis disproportion 8 Others	

Section 2: Neonatal related characteristics

Serial No	Question		Possible Response	Code
201	Sex		1 male 2 female	
202	Gestational age (weeks)		_____	
203	Birth weight (gram)		_____	
204	Presentation		1 normal 2 breach	
205	Congenital malformation		1 yes 2 no	
206	Fetal heart-beat per minute		_____	
207	APGAR score	1st minute	_____	
		5th minute	_____	
208	Birth asphyxia presence		1 Yes 2 No	
208	NICU admission		1 yes 2 no	
209	Was the neonate bag-mask ventilated		1 yes 2 no	
210	Was the neonate intubated		1 yes 2 no	
211	Was chest compression done		1 yes 2 no	

Section 3: Perioperative characteristics

Serial No	Question	Possible Response	Code
301	Surgery performer	1 Gynecologist 2 R4 resident 3 R3 resident	
302	Anesthesia performer	1 BSC students 2 Professionals	
303	Anesthesia type	1 Spinal anesthesia 2 General anesthesia	
If spinal anesthesia (304-308)			
304	Type of spinal anesthesia	1 Conventional 2 Rapid sequence	
305	Type of drug	1 Bupivacaine 2 Lidocaine	

		3 Others (specify)	
306	Number of attempt	_____	
307	Baseline Vital sign	1 BP _____	
		2 HR _____	
308	Lowest vital sign before delivery	1 BP _____	
		2 HR _____	
If General anesthesia (309-313)			
309	Type of induction	1 Rapid sequence 2 Modified rapid sequence	
310	Intubation attempt	1 One attempt 2 Multiple attempt	
311	Anesthetic drug	1 Ketamine 2 Propofol 3 Other (specify)	
312	Baseline vital sign	1 BP _____	
		2 HR _____	
313	Lowest vital sign before delivery	1 BP _____	
		2 BP _____	
314	Induction to incision time (minute)	_____	
315	Incision to delivery (minute)	_____	
316	Decision to delivery time (minute)	_____	
317	Intraoperative complications before delivery	_____	

ANNEX 3: Supplemental Table

Table 8: Apgar score supplemental table(55).

SCORE	0 points	1 point	2 points
Appearance (Skin color)	Cyanotic / Pale all over	Peripheral cyanosis only	Pink
Pulse (Heart rate)	0	<100	100-140
Grimace (Reflex irritability)	No response to stimulation	Grimace or weak cry when stimulated	Cry when stimulated
Activity (Tone)	Floppy	Some flexion	Well flexed and resisting extension
Respiration	Apneic	Slow, irregular breathing	Strong cry

DECLARATION

I hereby declare that this MSc thesis is my original work and has not been presented for a degree in this or any other university, and that all sources of materials used for the thesis have been fully acknowledged.

Name: _____

Signature: _____

Name of the institution: _____

Date of submission: _____

This MSc thesis has been submitted for examination with my approval as a University advisor

Name and Signature of the first advisor _____

_____

Name and Signature of the second advisor _____

_____