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Determinants of Stillbirth among Mothers Who Gave Birth in Bahir Dar City Public Hospitals, Northwest, Ethiopia

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Abstract

Background

Stillbirth is a devastating adverse pregnancy outcome that imposes direct, indirect, and intangible costs on women, their families, healthcare providers, governments, and society at large. Efforts to reduce stillbirth rates are often hindered by an incomplete understanding of the underlying risk factors.

Objective

This study aimed to identify determinants of stillbirth among mothers who gave birth in public hospitals of Bahir Dar city, Amhara region, Northwest Ethiopia, in 2021.

Methods

An institution-based, unmatched, retrospective case-control study was conducted through medical record review of 441 mothers (147 cases and 294 controls) from April 1–30, 2021. Mothers' charts with stillbirths and live births were included as cases and controls, respectively. Data were collected using a structured checklist, selected via simple random sampling, coded in EpiData version 3.1, and analyzed in SPSS version 23. Binary logistic regression was used to estimate crude odds ratios (COR) with 95% confidence intervals (CI), while multivariable logistic regression identified independent predictors. Statistical significance was set at $p < 0.05$.

Results

Determinants of stillbirth included referral from other health facilities [AOR = 1.89, 95% CI: 1.00–3.56], hypertensive disorders during pregnancy [AOR = 3.48, 95% CI: 1.83–6.64], antepartum hemorrhage [AOR = 6.10, 95% CI: 2.45–15.13], previous history of stillbirth [AOR = 3.91, 95% CI: 1.30–17.75], preterm delivery [AOR = 2.15, 95% CI: 1.08–4.26], and low birth weight [AOR = 4.10, 95% CI: 1.89–8.91].

Conclusion

Stillbirth in the study area was significantly associated with referral status, previous history of stillbirth, hypertensive disorders, antepartum hemorrhage, preterm delivery, and low birth weight. Addressing these risk factors requires expanding and decentralizing emergency obstetric services, strengthening antenatal screening and management, and improving the referral system.

Introduction

Stillbirth is defined as a fetus born with no sign of life, weighing more than 1000 grams, or with more than 28 completed weeks of gestation. The death is indicated by the fact that after such expulsion, the fetus

does not breathe or show any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles (1).

World Health Organization estimated that 2.7 million stillbirths were estimated worldwide in 2015. It is a death that occurs just when parents expect to welcome a new life and an important global health problem affecting over 7000 families every day (18.4 per 1000 total births). Almost all (98%) of stillbirths occur in low- and middle-income countries and more than three-quarters of them in South Asia and Sub-Saharan Africa (2). Sub-Saharan Africa (SSA) is particularly affected, with about a third of all cases worldwide and a stillbirth rate of 28.3 per 1000 births. About 880,000 stillbirths occur annually, 60% of which affect poor and rural families (3).

Ethiopia is one of the SSA countries that has a high stillbirth rate, ranging from 25.5–33 per 1,000 live births (4, 5). In the Amhara region, where the study was conducted, the rate of stillbirth was high in 2017, at 85 per 1,000 live births (6).

According to previous studies, several factors were reported to be associated with the occurrence of stillbirth. From those factors, socio-demographic factors ((young teenage mothers (7–9) and advanced maternal age of 35 years and above (10–13), rural residence (14), access to care-related factors (lack of antenatal care(10–13, 15), referral from another institution (10, 13, 16), not taking at least two doses of tetanus toxoid vaccine (17)) were reported to be associated with stillbirth.

The period after a stillbirth is a traumatic experience that has extensive multi-dimensional consequences. The impact does not remain with the loss of the newborn; it is also associated with direct, indirect, and intangible costs to women, their partners and families, healthcare providers, the government, and the wider society. The term intangible costs encompasses the psychological dimensions of stillbirth. It involves negative psychological effects, reduced social functioning, family and relationship disruption and breakdown, and negative effects on employment. It had been also linked to post-traumatic stress disorder, anxiety, suicidal thoughts, and depression for the mother (18). About 60–70% of mothers who experience stillbirth reported depressive symptoms. For some, these symptoms become pathological and long-lasting. (19). Many parents also reported feelings of distress that persisted into subsequent pregnancies. Parents were afraid to prepare for the birth of their subsequent baby, losing their confidence in parenthood and being daunted by fears about the potential loss of another child (20).

The economic consequence of stillbirth, which involves all costs of medical care and investigations at the time of stillbirth and in subsequent pregnancies, was estimated to be 10–70% greater than the cost of a live birth (20).

Although mothers, partners, and their families suffer most of the worst of stillbirth, it does not all experiences are positive for healthcare providers. Healthcare providers are also affected by far-reaching, so-called intangible costs personally and professionally. The professional effect of stillbirth was characterized by the way that professionals attending to a woman who had a stillbirth may have fear of litigation and disciplinary action, resulting in diminished emotional availability, stress, state of guilt, anger, self-blame, self-doubt, anxiety, and sadness (21).

However, stillbirth has been termed an ‘invisible death’ due to being neglected as a public health issue of importance to society and health policymakers. It is overlooked in many societies as a fitness monitoring, both internationally and often also at the national level. It is not counted in the Millennium Development Goals, nor tracked by the United Nations, nor in the global burden of disease metrics, and now, continues in the sustainable development goal agenda (2, 22).

Attempts to lower the stillbirth rate further may be hampered by an incomplete understanding of the risk factors leading to the majority of stillbirths. Determining a reasonable explanation of the stillbirth also aids maternal coping, helps to lessen any perceived guilt, permits more accurate counseling regarding recurrence risk, and prompts therapy or intervention to prevent a similar outcome in subsequent pregnancies. Studies conducted in the country on determinants of stillbirth are limited in number, and almost all the research so far is based on single institution-based settings, which provide limited usefulness for generalizing and designing interventions at the health systems level for addressing the problem as compared to multi-setting studies. Hence, it was within this context that this case-control study was conducted to identify determinants of stillbirth among mothers who gave birth in Bahir Dar City public hospitals, in the Northwest, Ethiopia.

Methods and Materials

Study design, setting, and population

The institution-based unmatched retrospective case-control study design was conducted from April 1–30,2021. The study was conducted in Bahir Dar city public hospitals. Bahir Dar city is one of the ten most beautiful cities in Africa and the capital city of the Amhara region, Ethiopia. It is 563 km from Addis Ababa. Administratively, the city is divided into 9 sub-cities. The altitude of the city is between 648 and 1300 meters above sea level. According to the Amhara Bureau of Finance and Economic Development (BOFED), the population of Bahir Dar city was estimated to be 339,683. Among these, 156,376(46%) of them are females (23).

The city had one specialized, one referral, and one primary government hospital (Tibebe Ghion Specialized Hospital, Felege Hiwot Comprehensive Referral Hospital, and Addis Alem primary hospital respectively), 11 health centers (including one private health center), 10 health posts and one family guidance association clinic, 4 private general hospital, and 35 medium private clinics. Among public health facilities, 4 public facilities named Tibebe Ghion Specialized Hospital, Felege Hiwot Comprehensive Referral Hospital, Addis Alem Primary Hospital, and Bahir Dar Health Center were provided Emergency Obstetric and Newborn Care services during the study period.

According to the Bahir Dar City Zone Health Department 2010 E.C. report, there were 15,208 annual deliveries (23). According to reports from the respective hospitals where data was collected, total deliveries conducted from January 1, 2020, to December 31, 2020, 3472, 5163, and 2604 in Tibebe Ghion Specialized Hospital (24), Felege Hiwot Comprehensive Referral Hospital (25), and Addis Alem primary hospital(26) respectively.

All still and live births after 28 weeks of pregnancy in the last year in Bahir Dar City public hospitals were considered as source populations.

Inclusion and exclusion criteria.

Mothers who had stillbirths as documented on their charts by the managing physician were included as a case, and those who had live births were included as a control. Mothers with unknown gestational age and birth weight and mothers whose charts didn't include the status outcome of the newborn (dead or alive) were excluded from the study.

Sample size determination and sampling techniques.

The sample size was calculated based on an unmatched case-control formula using Epi-info version-7 Fleiss formula calculator with assumption of power = 80%, two-sided level significance 95%, 1:2 case-to-control ratio. From a previous unmatched case-control study on determinants of stillbirth (17), a variable STI (percent controls exposed = 1.2%, AOR = 5.7) was selected because it was the exposure variable that gave the highest 420, which was the largest sample size from the alternative significant factors. Adding 5% contingency for incomplete checklists, the final sample size was 441(147 cases and 294 controls).

The allocation of samples to each hospital was determined based on a proportion of caseload (delivery reports) using reports from January 1, 2020, to December 31, 2020; were 3472 (83 stillbirths and 3389 live birth), 5163(101 stillbirths and 5062 live birth) and 2604(63 stillbirth and 2541 live birth) in Tibebe Ghion specialized hospital, Felege Hiwot comprehensive referral hospital, and Addis Alem primary hospital respectively.

A list of medical registration numbers was developed separately for cases and controls by registering the medical record number of mothers by taking lists from the delivery registration book in each hospital registered from January 1, 2020, to December 31, 2020. Then, the medical record number of cases and controls was selected randomly from separate lists of cases and controls, respectively, by using the lottery method. Following the selection of cases and controls, data collectors and card room workers selected charts of mothers from the card room using medical record numbers. Then, the data collectors reviewed the woman's referral, history, laboratory results, partograph, decision notes, progress notes, delivery summary/procedure notes, and operation notes and filled in the checklist. Incomplete charts on major variables under study (no information about the antenatal period, labor status, and delivery summary or procedure notes) were replaced by randomly selected charts in the same facility (Fig. 1).

Study variables

The dependent variable was stillbirth dichotomized as (1 = YES and 0 = NO) whereas independent variables were maternal age at delivery, residence, referral status, ANC visits, TT vaccination, iron-foliate intake during pregnancy, parity, history of abortion, and history of stillbirth, STI, HIV serostatus, hypertensive disorder during pregnancy, maternal DM, APH, polyhydramnios, oligohydramnios, PROM, chorioamnionitis, Rh factor, and maternal anemia, the onset of labor, partograph use during labor follow up, labor augmentation,

meconium-stained amniotic fluid, non-reassuring fetal heart rate, obstructed labor, uterine rupture, cord accident, mode of delivery, number of fetuses born, gestational age at delivery, fetal presentation, birth weight of newborn, fetal congenital anomaly, and sex of the newborn.

Operational definitions

Stillbirth was defined in this study as a baby born dead after 28 weeks of gestation or with a birth weight of ≥ 1000 grams, which was explained by an APGAR score of 0 at 1st and 5th minutes (15).

Antepartum stillbirth was defined as delivery of any fetus after 28 weeks of gestation, or with a birth weight ≥ 1000 grams, with an APGAR score of 0 at 1st and 5th minutes, and signs of maceration as recorded by the delivering clinician,/Or absent fetal heart sound before the initiation of labor (15, 27).

Intrapartum stillbirth was defined as the delivery of any fetus after 28 weeks of gestation, or with a birth weight ≥ 1000 grams, and had an APGAR score of 0 at 1st and 5th minutes, without signs of maceration as recorded by the delivering clinician/Or had detectable fetal heart sounds upon labor admission, but died during the intrapartum period and thus had an APGAR score of 0 at 1st and 5th minutes (15, 27).

Antenatal care attendance was determined based on whether a mother attended ANC visits during which she received a clinical examination, counseling, and medication (if needed) from a skilled provider as per guidelines (15).

Gestational age was estimated based on documentation in the medical charts, using the date of the last normal menstrual period (LNMP) as documented in the hospital record by Naegele's rule and/or based on ultrasound if it was performed before 22 + 0 weeks of gestation (28, 29).

Partograph use

If all the data on the three components of the partograph (fetal condition, progress of labor, and maternal condition) were completed as per WHO protocol, a partograph is considered utilized (30).

Incomplete charts are charts that were found incomplete on major variables under study (no information about antenatal period, labor status, and delivery summary or procedure notes) (31).

No reassuring fetal heart rate patterns of a fetus are defined as a fetal heart rate below 120 beats/minute (bradycardia) or above 160 beats/minute (tachycardia) for 10 minutes or more (32).

Cord accidents in this study comprise cord prolapse, cord knots, and tight coils of cord around the fetal neck (8).

Data collection tool and procedures

Data was collected by using a pretested and structured checklist, which was developed in the English language after a thorough literature review (7–17, 29, 31, 33–51). The checklist consists of relevant

information on socio-demographic data, obstetric history, medical history, delivery history, birth outcome, and fetal-related characteristics. Three post-basic 2nd year and three generic 4th year midwifery students were involved in the data collection, and a degree-holder midwife was involved as a supervisor.

Data quality control

Both data Collectors and the supervisor were trained for two days to be familiarized with data collection tools and ethical protocols.A checklist pre-test was carried out on 5%(n = 22) of sample size before the actual data collection at Felege Hiwot comprehensive referral hospital and modifications of the checklist were made on rephrasing and skipping patterns. The principal investigator and supervisor did Continuous follow-up throughout the data collection period. The collected data was checked for completeness, accuracy, and clarity by the supervisor daily, and anything unclear was communicated to the data collectors, and necessary correction was done accordingly to the aims of the study.

Data processing and analysis

After data collection was completed, each completed checklist was given a unique code by the principal investigator, entered using Epidata version 3.1, and then exported to SPSS version 23 for analysis. The data were cleaned for inconsistencies. Descriptive statistics were used to summarize the data. Mean and standard deviation were used to describe normally distributed continuous variables. Comparison of the mean mothers' age, newborn birth weight, and gestational age between cases and controls was done using an independent sample *t*-test. All assumptions of binary logistic regression were checked accordingly, and bivariate analysis was employed to assess the association between independent and dependent variables. The multicollinearity test was tested by variance inflation factor (VIF) to see the correlations between predictors of outcome variables and did not show any significant collinearity between the risk factors. Multivariable logistic regression was used to identify independent risk factors for stillbirth and to control for confounding. To identify independent risk factors for stillbirth and control for confounding, variables that had significant association with stillbirth at $p < 0.05$ in bivariate analysis were included in the multivariable logistic regression model. Thus, the crude odds ratio (COR) from bivariate binary logistic regression and the adjusted odds ratio (AOR) from multivariable binary logistic regression are reported. A confidence interval of 95% was used to see the precision, and the level of significance was taken at p-value < 0.05. Finally, the results were presented using tables and texts.

Results

A total of 441 study participants were included, making the response rate of 100%. The age of the respondents ranges from 18 to 42 both in cases and controls. Around half, 73(49.7%) of cases and 186(63.3%) of controls, are urban residents. Regarding admission status, 120 (81.6%) of cases and 204(69.4%) of controls are referred from other health facilities.

One hundred forty (95.2%) of cases and 284(96.6%) of controls had ANC visits during their pregnancy, and 138 (93.9%) of cases and 284 (96.9%) of controls took at least two doses of the TT vaccine (Table 1).

Obstetric complications and maternal health-related Characteristics

Among the study participants, 3(2%) of cases and 6(2%) of controls had a history of STI, whereas 6(4.1%) and 7(2.2 %) of cases and controls were living with HIV, respectively. Forty-three (29.3%) of cases and 8(2.7%) of controls had APH during the current pregnancy. About 50 (34%) of cases and 24(8.2%) of controls had hypertensive disorder during the current pregnancy (Table 2).

Intrapartum and fetal-related characteristics

From a total of 147 cases, 78(53.1%) and 69(46.9%) were antepartum (macerated) and Intrapartum (fresh) stillbirths, respectively. Almost all 140(95.2 %) and 281 (95.6%) of cases and controls' labor was started spontaneously, and 11(7.5%) of cases and 20(6.8%) of controls' labor was augmented.

The mean GA among cases was 36^{+5} weeks (SD ± 3^{+6} weeks) and 39 (SD± 2^{+3}weeks among controls. There is a statistically significant difference in mean GA between cases and controls ($p<0.001$). Regarding birth weight, the mean birth weight among cases was 2.5 kg and 3 kg among controls. There is a statistically significant difference in mean birth weight among cases and controls ($p<0.001$) (Table 3).

Factors associated with stillbirth

On binary logistic regression analysis 14 variables (maternal age>35 years, rural residence, grand-multiparity, referred from other health institution, not vaccinated for at least two doses of TT vaccination, not taking iron supplementation, parity, PROM, hypertensive disorder during pregnancy, DM, APH, previous history of stillbirth, Anemia, premature delivery, and low birth weight) showed a significant association with a stillbirth at 5 % level of significance.

However after adjusting for confounding factors in multivariable logistic regression analysis; by using enter method, being referred from other health facilities [AOR =1.89, 95% CI 1.00-3.56], hypertensive disorder during pregnancy [AOR=3.48, 95% CI 1.83-6.64], Antepartum hemorrhage [AOR 6.10,95% CI 2.45-15.13], previous history of stillbirth [AOR= 3.91, 95% CI 1.30-17.75], Preterm delivery [AOR=2.15, 95% CI 1.08-4.26], and low birth weight [AOR=4.1, 95% CI 1.89-8.91] were identified as predictors of stillbirth in the study area (Table 4).

Discussion

In this unmatched case-control study, access to care, maternal health, and obstetric-related and fetal-related factors were identified as predictors of stillbirth.

The odds of experiencing stillbirth were 1.86 times higher among mothers referred from other health facilities compared to those who presented directly from home. This finding is consistent with studies conducted in sub-Saharan Africa, including Cameroon and Ghana (10, 16, 34). A plausible explanation is that most referred cases originated from rural peripheral health facilities and often involved serious complications. The distance to referral hospitals contributes to delays in receiving care, increasing the likelihood that a fetus alive at the time of referral may die before the mother reaches the higher-level facility,

particularly in cases of fetal distress (34). In contrast, a study conducted at Jimma University Specialized Hospital in Ethiopia reported a 70% reduction in stillbirths among referred pregnant women compared to those not referred (13). This discrepancy may be attributed to differences in study area, period, design, and sample size.

Mothers who experienced hypertensive disorders during pregnancy had 3.34 times higher odds of stillbirth compared to their counterparts. This association has also been demonstrated in several studies conducted in Tigray, Ethiopia (42), the North Shewa Zone of the Oromia region, Ethiopia (41), sub-Saharan Africa (10), Nigeria (12), Tanzania (40), and Cameroon (16). The link between hypertensive disorders and stillbirth is physiologically plausible and well described in the literature. Hypertensive disorders impair remodeling of the spiral arteries, leading to uteroplacental insufficiency, which can result in chronic fetal insult, intrauterine growth restriction, and ultimately intrauterine fetal death (40). Uteroplacental insufficiency may further manifest as placental infarction, abruptio placentae, or fetal-maternal hemorrhage. These mechanisms reduce fetal growth and increase the risk of fetal death. Elevated maternal serum α-fetoprotein, often associated with fetal-maternal hemorrhage, has also been identified as a marker of stillbirth (42).

Antepartum hemorrhage (APH) increased the odds of stillbirth sixfold compared to pregnancies without APH. This finding is consistent with studies conducted in southwestern Ethiopia, Nigeria, Cameroon, Northern Tanzania, and Nepal (12, 15, 16, 40, 43). A possible explanation is that severe forms of APH may not always present with obvious external bleeding but remain as concealed hemorrhage. In such cases, fetal compromise may not be readily detected, and late presentation to hospitals often allows APH to progress to more severe stages before clinical intervention is possible. This reduces the likelihood of salvaging the fetus from life-threatening, rapidly developing anemia, which diminishes oxygenation and leads to asphyxia, ultimately resulting in intrauterine fetal death (12).

Mothers with a previous history of stillbirth had 3.61 times higher odds of experiencing stillbirth compared to their counterparts. This finding is consistent with studies conducted in northwest Ethiopia, sub-Saharan Africa, Nepal, and India (10, 11, 17, 38, 39). The association may be explained by undiagnosed chromosomal abnormalities that predispose to recurrent fetal death. Another possible explanation is the presence of chronic or repeated maternal comorbidities that remain undetected and contribute to unexplained recurrent fetal loss (17).

Preterm newborns had 2.15 times higher odds of dying compared with newborns delivered at term. This finding is consistent with studies conducted in the central zone of Tigray, Ethiopia (42), Mizan Tepi, Ethiopia (43), sub-Saharan Africa (10), Zimbabwe (45), Cameroon (16), Tanzania (40), and Nepal (17), all of which reported that preterm infants are at greater risk of stillbirth. A plausible explanation is that premature infants are more susceptible to ischemia due to incomplete blood-brain barrier formation. In addition, preterm babies often face multiple morbidities, including organ system dysfunction related to immaturity—particularly lung immaturity, which can result in respiratory failure, asphyxia, and distress leading to stillbirth (42). Furthermore, preterm birth is frequently associated with underlying placental insufficiency or intrauterine growth restriction. A compromised fetus is less able to withstand labor and transition to extrauterine life, increasing the risk of intrapartum stillbirth, or may fail to initiate preterm labor, resulting in antepartum death (39).

The odds of stillbirth were four times higher among low-birth-weight newborns compared to those with normal birth weight. This finding is consistent with studies conducted in Oromia Regional State, Southeast Ethiopia (31), SSA (10), and Northern Tanzania (40). Low birth weight often results from fetal growth restriction or preterm birth, both of which are linked to multifaceted public health challenges. These include long-term maternal malnutrition, chronic illnesses such as hypertension and pre-gestational diabetes mellitus, infections, and inadequate health care either before conception or during pregnancy. Such conditions contribute to intrauterine growth restriction, which increases the risk of insufficient oxygen and nutrient supply to the fetus, ultimately leading to stillbirth (31).

The odds of stillbirth were four times higher among low birth weight newborns relative to newborns who had normal birth weight. The findings of this study were consistent with the studies conducted in Oromia Regional State. This may be because low birth weight may result from both fetal growth restriction and preterm birth secondary to multifaceted public health problems. This may include long-term maternal malnutrition, ill health (hypertension, pre-gestational DM, infections), and poor health care that presents pre-conception or during pregnancy. This can result in intrauterine growth restriction, increasing the risk of the fetus not getting enough oxygen or other important nutrients, and stillbirth.

Limitations of the study

This study has several limitations that should be acknowledged. First, it relied on hospital-based data originally recorded for clinical purposes rather than research, which limited control over variables not documented in maternal records despite their relevance to the study. Second, as the study was facility-based, the findings may not be generalizable to the wider community. Third, variability in the quality of clinical reporting, influenced by differences among clinicians, may have introduced inconsistencies. Finally, since the data collectors were midwives, potential variation in the abstraction and interpretation of medical records represents another limitation.

Strengths of the study

Most of the associations found in this study were consistent with other studies in determinants of stillbirth can, in turn, increase further confidence in our analysis and the reliability of the findings.

Conclusion and recommendation

Being referred from another health facility, previous history of stillbirth, hypertensive disorder during pregnancy, APH, preterm delivery, and low birth weight were identified as determinants of stillbirth in the study area. Therefore, it is better if the government and the Federal Ministry of Health emphasize decentralizing healthcare provision centers to evaluate the existing referral system and supervise health facilities on their proper use and implementation. We recommend that district and private hospitals and health centers establish a minimum package for basic emergency obstetric and neonatal care to manage identified risk factors without the need for referral.

Health professionals are recommended to give close follow-ups in subsequent pregnancies if the woman has a history of stillbirth and to use ANC follow-up as an opportunity to screen and investigate antenatal

risk factors for stillbirth, as well as to provide counseling to women about dangerous symptoms and the need for early hospital arrival. Ultrasound should also be used for the early identification of high-risk pregnancies for its many presumed benefits, including earlier detection of placental abnormalities, intrauterine fetal growth restriction and to monitor fetal well-being.

Abbreviations

ANC; antenatal care, AOR; Adjusted odds ratio, APH; Ante Partum Hemorrhage, C/S; Cesarean Section, CI; confidence interval, COR; Crud Odd Ratio, DM; diabetes mellitus, GA; Gestational Age, HIV; Human Immune Deficiency Virus, SPSS; Statistical Package for Social Science; SSA; Sub-Saharan Africa, STI; Sexually Transmitted Infections, TT; Tetanus Toxoid.

Declarations

Ethical Approval and Accordance

Ethical clearance was obtained from the Institutional Review Board (IRB) of Bahir Dar University, College of Medicine and Health Sciences, on March 29, 2021 (Reference No. 208/2021). Permission to review charts was secured from each public hospital medical director and the head of the respective medical record units. The study was conducted in accordance with the principles of the Declaration of Helsinki. Strict confidentiality was maintained throughout data collection, with only coded identifiers used; personal identifiers such as names and phone numbers were not recorded. All information extracted from client charts was kept confidential and accessible only to the investigators, solely for the purposes of this study.

Consent to Participate

Informed written consent was obtained from each hospital medical director before data collection.

Clinical trial number: not applicable.

Consent for publication

Not applicable

Availability of data and materials

All pertinent data are included in the manuscript. The dataset is available and can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors contributed to the conception of the research idea, study design, data collection and supervision, analysis and interpretation of the results, and manuscript write-up. All authors have read and approved the final manuscript.

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Tables

Table 1

Demographic and obstetric characteristics of the participants in Bahir Dar city public hospitals, Amhara region, Northwest, Ethiopia, 2021 (n = 441).

Variable Categories		Cases(n = 147) No (%)	Control(n = 294) No (%)
Age	< 25 25–34 ≥ 35	16(10.9) 114(77.6) 17(11.5)	35(11.9) 236(80.3) 23(7.8)
Residence	Urban Rural	73(49.7) 74(50.3)	186(63.3) 108(36.7)
Referral status	Self-admitted Referred from other facility	27(18.4) 120(81.6)	90(30.6) 204(69.4)
Institution they referred from(n = 324)	Primary Care Center Private centers	87(59.1) 33(22.4)	159(54.08) 45(15.3)
ANC Visit	Yes No	140(95.2) 7 (4.8)	284(96.6) 10(3.4)
No ANC visits (n = 424)	≥ 4 visits < 4 visits	127(86.4) 13(8.8)	272(92.5) 12(4.1)
Two doses of TT vaccine	Yes No	138 (93.9) 9 (6.1)	284(96.6) 10(3.4)
Iron-folate intake	Yes No	136(92.5) 11(7.5)	285(96.9) 9(3.1)
Parity	Primipara Multipara Grand Multipara	107(72.8) 19 (12.9) 21 (14.3)	224(76.2) 39(13.3) 31(10.5)
History of abortion	Yes No	17(11.6) 130(88.4)	36(12.2) 258(87.8)
Type abortion history (n = 53)	Induced Spontaneous	1(0.6) 16(10.9)	3(1.0) 33(11.2)
History of stillbirth(n = 124)	Yes No	17(13.7) 30(24.2)	8(6.5) 69(55.6)

Table 2

Obstetric complications and maternal health related Characteristics of Participants in Bahir Dar city public hospitals, Amhara region, Northwest, Ethiopia, 2021 (n = 441).

Variable Categories		Case (n = 147) No (%)	Control(n = 294) No (%)
History of STI	Yes No	3(2.0) 144(98)	6(2.0) 288(98)
Laboratory/clinical diagnosis of STI(n = 9)	Syphilis Hepatitis B virus	1(0.6) 2(1.3)	1(0.3) 5(1.7)
HIV Sero-status	Non-Reactive Reactive Unknown	131(89.1) 6(4.1) 10(6.8)	263(89.4) 7(2.4) 24(8.2)
Hypertensive disorder during pregnancy	Yes No	50(34.0) 97(66.0)	24(8.2) 270(91.8)
Type of hypertensive Disorder (n = 74)	Eclampsia Preeclampsia Others*	8(5.4) 36(24.5) 6(4.1)	0 20(6.8) 4(1.3)
Maternal Rh factor	Rh Negative Rh Positive	15(10.2) 132(89.8)	35(11.9) 259(88.1)
APH	Yes No	43(29.3) 104(70.7)	8(2.7) 286(97.3)
Causes of APH (n = 51)	Abruption Placenta prevea Others**	30(20.4) 5(3.4) 8(5.4)	7(2.4) 1(0.3) 0
Polyhydramnious	Yes No	1(0.7) 146(99.3)	4(1.4) 290(98.6)
Oligohydramnious	Yes No	4(2.7%) 143(97.3)	11(3.7) 283(96.3)
PROM	Yes No	9(6.1) 138(93.9)	9(3.1) 285(96.9)
Type of PROM(n = 18)	Term Preterm	8(5.4) 1(0.6)	7(2.4) 2(0.6)
Chorioamnionitis	Yes No	6(4.1) 141(95.9)	0 294(100)
DM	Yes No	15(10.2) 132(89.8)	6(2.0) 288(98)

* Indicated that (Superimposed Preeclampsia, Chronic hypertension, Gestational hypertension).

**Indicates that (spontaneous uterine scar dehiscence and local cause (cervical tear/laceration before delivery).

Variable Categories		Case (n = 147) No (%)	Control(n = 294) No (%)
Anemia	Yes	20(13.6)	14(4.8)
	No	127(86.4)	280(95.2)
* Indicated that (Superimposed Preeclampsia, Chronic hypertension, Gestational hypertension).			
**Indicates that (spontaneous uterine scar dehiscence and local cause (cervical tear/laceration before delivery).			

Table 3

Intra-partum and fetal related characteristics of Participants in Bahir Dar city public hospitals, Amhara region, Northwest, Ethiopia, 2021, (n = 441).

Variable Categories		Case (n = 147) No (%)	Control (n = 294) No (%)
What was onset of labor	Spontaneous Induced Elective C/S	140(95.2) 4(2.7) 3(2.1)	281(95.6) 6(2.0) 7(2.4)
Partograph use	Yes No Come at second stage C/S before active labor*	119(81.0) 7(4.7) 16(10.9) 5(3.4)	184(62.6) 35(11.9) 45(15.3) 30(10.2)
Labor augmentation	Yes No	11(7.5) 136(92.5)	20(6.8) 274(93.2)
Color of aminotic fluid	Clear Meconium stained	140(95.2) 7(4.8)	276(93.8) 18(6.1)
Degree of meconium (n = 25)	Grade I Grade II	4(2.7) 3(2.0)	16(5.4) 2(0.6)
Non-reassuring fetal heart rate	Yes No	5(3.4) 142(96.6)	9(3.1) 285(96.9)
Type of Non-reassuring fetal heart rate(n = 14)	Tachycardia Bradycardia	1(0.6) 4(2.7)	6(2.0) 3(1.0)
Obstructed labor	Yes No	3(2.0) 144(98.0)	3(1.0) 291(99)
Uterine rapture	Yes No	7(4.8) 140(95.2)	2(0.7) 287(99.3)
Cord accident	Yes No	3(2.0) 144(98.0)	4(1.4) 290(98.6)
Mode of delivery	Spontaneous Vaginal Delivery C/S Others**	126(85.7) 7(4.8) 14(9.5)	228(77.6) 59(20.0) 7(2.4)
Number of fetus born	Singleton Twin	145(98.6) 2(1.4)	287(97.6) 7(2.4)
GA at delivery	Term Preterm Post Term	67(45.6) 70(47.6) 10(6.8)	234(79.6) 35(11.9) 25(8.5)
Fetal Presentation	Cephalic	141(95.9)	278(94.6)

*Elective C/S and C/S at latent first stage of labor,

**Assisted breech, forceps, vacuum, destructive, laparatomy

Variable Categories		Case (n = 147) No (%)	Control (n = 294) No (%)
	Non-Cephalic	6(4.1)	16(5.4)
Birth weight of newborn	Low Birth Weight(< 2500g) Normal Birth Weight (2500-4000g) Macrocosmic(> 4000g)	74(50.3) 68(46.3) 5(3.4)	19(6.5) 265(90.1) 10(3.4)
Fetal congenital anomaly	Yes No	9(6.1) 138 (93.9)	1(0.3) 293(99.7)
Type of anomaly(n = 10)	Neural Tube Defect Chari II malformation Ventriculomegaly Dandy-Walker syndrome	4(2.7) 2(1.3) 2(1.3) 1(10.0)	1(0.3) 0 0 0
Sex of newborn	Female Male	62(42.2) 85(57.8)	127(43.2) 167(56.8)
*Elective C/S and C/S at latent first stage of labor,			
**Assisted breech, forceps, vacuum, destructive, laparatomy			

Table 4

Multiple Logistic regression analysis for determinants of stillbirth among study participants in Bahir Dar city public hospitals, Amhara region, Northwest, Ethiopia, 2021 (n = 441).

Variable category		Stillbirth		COR(95% CI)	AOR(95% CI)	P-value
		Cases No (%)	Controls No (%)			
Age	< 25 25–34 ≥ 35	15 (10.2) 108 (73.5%) 24 (16.3)	34 (11.6) 237 (80.6) 23 (7.8)	1 1.03[0.54–1.97] 2.36[1.02–5.44]	1 1.27[0.55–2.96] 1.71[0.56–5.19]	0.568 0.344
Place of Residence	Urban Rural	73 (49.7) 74 (50.3)	186 (63.3) 108 (36.7)	1 1.74[1.16–2.60]	1 1.57[0.92–2.67]	0.096
Admission status	Self-admitted Referred	27 (18.4) 120(81.6)	90 (30.6) 204 (69.4)	1 1.96[1.20–3.18]	1 1.89[1.00-3.56]	0.047*
Two doses of TT vaccination	No Yes	9 (6.1) 138 (93.9)	10(3.4) 284 (96.6)	1.85[0.73–4.66] 1	1.16[0.23–5.74] 1	0.855
Iron supplementation	No Yes	16 (7.5) 131 (92.5)	21 (3.7) 273 (96.3)	1.58[1.08–3.14] 1	0.89[0.26–3.01] 1	0.862
Parity	Primipara Multipara Grand Multipara	107 (72.8) 19 (12.9) 21 (14.3)	224 (76.2) 39 (13.3) 31 (10.5)	1 1.02[0.56–1.84] 1.41[1.16–2.58]	1 0.80[0.36–1.76] 1.05[0.47–2.35]	0.588 0.898
PROM	Yes No	138 (93.9) 9 (6.1)	285 (96.9) 9 (3.1)	0.39[0.19–0.80] 1	2.80[.837 – 9.37] 1	0.095
Hypertensive disorder	Yes No	50 (34.1) 97 (65.9)	24 (8.2) 270 (91.8)	5.79[3.38–9.94] 1	3.48[1.83–6.64] 1	0.001*
APH	Yes No	43 (29.3) 104 (70.3)	8 (2.7) 286 (97.3)	14.78[6.72–32.48] 1	6.10[2.45–15.13] 1	0.001*

*Significant (p-value < 0.05)

A multiple logistic regression, “Enter” method was applied. Model fitness was checked by using Hosmer-Lemeshow goodness-of-fit test and was considered adequate when a significance value was > 0.05(p-value = 0.713).

Variable category		Stillbirth		COR(95% CI)	AOR(95% CI)	P-value
DM	Yes No	15 (10.2) 132 (89.8)	6 (2) 288 (98)	5.45[2.07–14.37] 1	1.89[0.53–6.64] 1	0.321
Previous history of stillbirth	Yes No	15 (10.2) 132 (89.8)	8 (2.7) 286 (97.3)	4.06[1.68–9.81] 1	3.91[1.30-17.75] 1	0.015*
Anemia	Yes No	20 (13.6) 127 (86.4)	14 (4.8) 280 (95.2)	3.15[1.54–6.43] 1	1.66[0.61–4.48] 1	0.316
GA at Birth	Term Preterm Post term	67 (45.6) 70 (47.6) 10 (6.8)	234 (79.6) 35 (11.9) 25 (8.5)	1 6.98[4.28–11.38] 1.39[0.63–3.05]	1 2.15[1.08–4.26] 1.62[0.68–3.85]	0.028* 0.268
Birth weight	Normal Low Macrocosmic	74 (50.3) 68 (46.3) 5(3.4)	265 (90.1) 19 (6.5) 10 (3.4)	1 12.81[7.24–22.66] 1.79[0.59–5.40]	1 4.1[1.89–8.91] 1.83[0.49–6.74]	0.001*0.363
*Significant (p-value < 0.05)						
A multiple logistic regression, “Enter” method was applied. Model fitness was checked by using Hosmer-Lemeshow goodness-of-fit test and was considered adequate when a significance value was > 0.05(p-value = 0.713).						

Figures

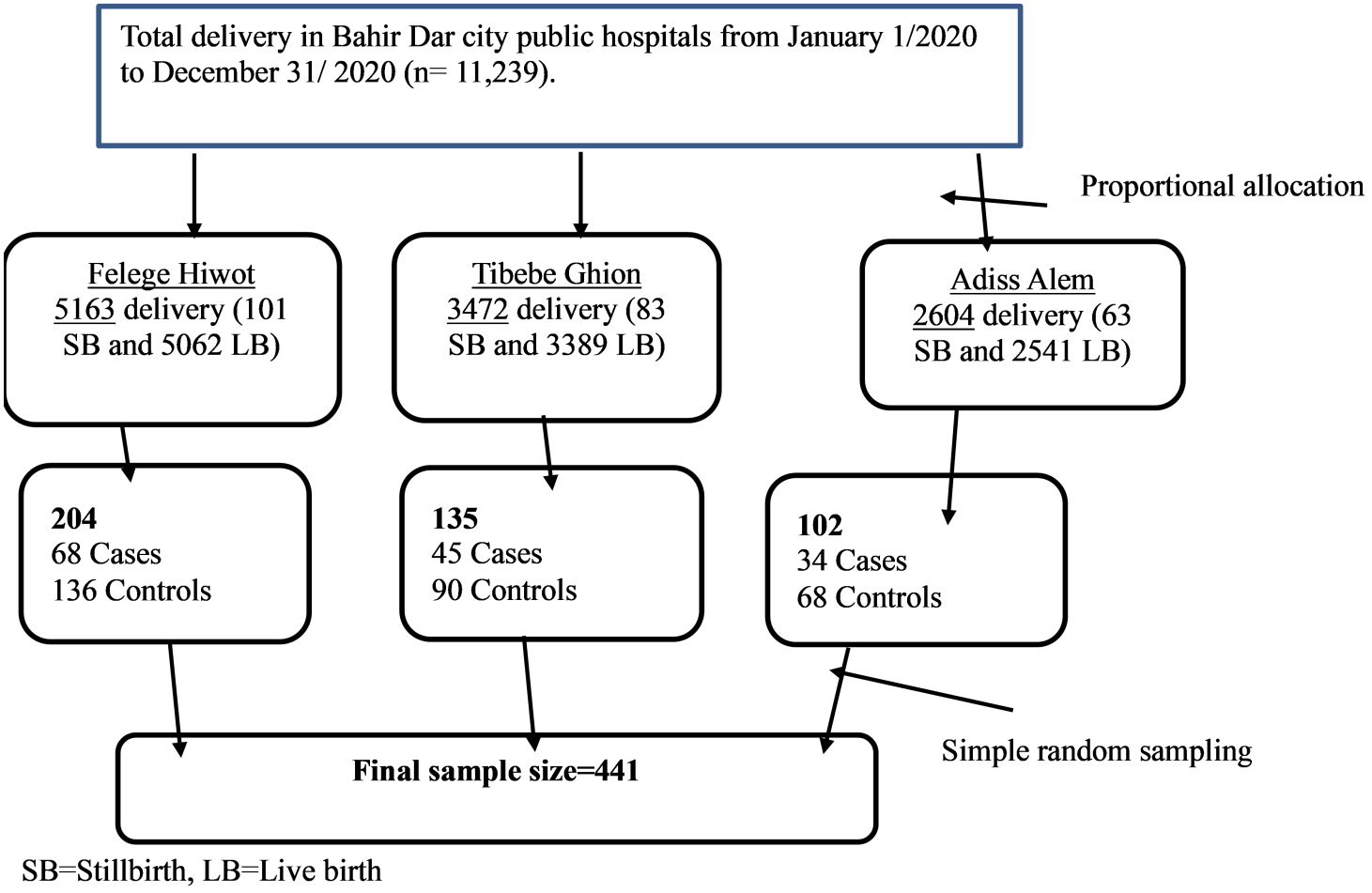


Figure 1

Sampling procedure of study participants in Bahir Dar city public hospitals, Amhara region, Northwest, Ethiopia, 2021.