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Original Article

Determinants of adverse birth outcome among newborn deliveries in Addis Ababa City, Ethiopia: Unmatched Case Control Study

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Abstract

Background: Adverse birth outcomes, including preterm birth, low birth weight, and stillbirth, remain major public health challenges worldwide, particularly in low- and middle-income countries. Despite advances in maternal health services in Ethiopia, evidence on factors associated with birth outcomes in public hospitals in Addis Ababa remains limited. This study aimed to identify factors associated with adverse birth outcomes among mothers who gave birth in selected public hospitals.

Methods: An institution-based, unmatched case-control study was conducted among mothers who gave birth in selected public hospitals in Addis Ababa, Ethiopia, from March 1 to June 30, 2022. Four hospitals were randomly selected from the 12 public hospitals offering delivery services. A total of 465 mothers (155 cases and 310 controls) were enrolled. Cases were mothers who delivered newborns with adverse birth outcomes (preterm birth <37 weeks, low birth weight <2500 g, or stillbirth). Controls were mothers who delivered normal live newborns. Cases were selected consecutively; controls were selected by systematic sampling (sampling interval k was calculated for each hospital based on delivery load). Data were collected using a structured pretested questionnaire, entered into Epi Data 3.1, and exported to SPSS 25 for analysis. Bivariable and multivariable binary logistic regression analyses were performed. Variables with $p \leq 0.25$ in bivariable analysis were entered into the multivariable model. Adjusted odds ratios (AORs) with 95% confidence intervals were calculated, and statistical significance was declared at $p < 0.05$.

Result: Pregnancy-induced hypertension (defined as new-onset hypertension ≥140/90 mmHg after 20 weeks of gestation) (AOR=2.99; 95% CI: 1.79-4.99), maternal HIV infection (AOR=3.04; 95% CI: 2.09-7.81), history of adverse birth outcome (AOR=3.07; 95% CI: 1.39-6.78), hemoglobin level <11 g/dL during labor (AOR=4.15; 95% CI: 1.80-6.53), and fewer than four ANC visits (AOR=4.29; 95% CI:

2.20-5.42) were independently associated with adverse birth outcomes.

Conclusions: This study identified pregnancy-induced hypertension, maternal HIV infection, previous adverse birth outcomes, maternal anemia, and inadequate antenatal care attendance as key factors associated with adverse birth outcomes. To reduce adverse birth outcomes in hospital settings in Ethiopia, there is a need to improve the quality of ANC and address maternal anemia and hypertension through early detection and treatment. HIV services should be integrated into maternal health. Updated WHO guidance recommends 8+ ANC contacts; health facilities should work toward this standard while maintaining the minimum of four visits as an initial target.

Key words: Adverse Birth outcome, Still Birth, Preterm Birth, Low Birth Weight, Ethiopia.

Introduction

Adverse birth outcomes are defined by the World Health Organization as events of low birth weight, preterm birth, stillbirth, or perinatal death (1).Although most pregnancies and childbirths are a joyful experience for most women, they sometimes end up in an adverse birth outcome(2). The adverse birth outcome is a multifactorial outcome that mainly includes preterm birth, low birth weight, stillbirth, macrosomia, congenital anomaly, and infant/neonatal death. It is a common health problem consisting of several health effects involving pregnancy and the newborn infant(3).

Birth outcomes are measures of health at birth, and their magnitude has dramatically decreased in the past 40 years. However, there is still a large gap between developing and developed countries(4). Adverse birth outcomes have significant difficulties in both developed and developing nations. According to the WHO 2019 report, the prevalence of neonatal mortality is 17 deaths per 1000 live births worldwide, and the cause of the majority of those deaths is linked to adverse birth outcome(5, 6). It has a great implication on the development of a country because they have a major effect on the health of newborns who are going to be the productive part of the country (16).

Globally, according to the WHO 2015 report, an estimated 15 million newborns are delivered preterm, and their consequences are the leading cause of mortality for children under the age of five, resulting in an estimated 1 million deaths every year. Many victims of preterm birth face lifelong disability, including learning disabilities and visual and hearing impairments (7).

Also, low birth weight (LBW) is an important indirect cause of neonatal deaths and leads to 60% to 80% of all neonatal deaths. The global magnitude of low birth weight is 15.5%, which accounts for the delivery of about 20 million LBW newborns every year, 96.5% of them in underdeveloped nations. (3). Furthermore, there are 2.6 million stillbirths in the world, with greater than 7178 mortalities per day. The majority of these mortalities occurred in developing nations. 98 percent happened in low- and middle-income countries. About half of all stillbirths occur during labor and delivery, indicating the greatest period of risk (13).

In Sub-Saharan Africa and South Asia, preterm birth accounts for over 60 percent of preterm deliveries globally. From the fifteen million newborns delivered too early every year, more than one million of them die as a result of complications associated with preterm birth. Low birth weight due to preterm birth or intrauterine growth restriction is also a foremost contributor to newborn and child mortality, including disability and chronic diseases

worldwide, particularly in Sub-Saharan countries (14).

In Ethiopia, the mortality of newborns less than 30 days was 30 deaths per 1000 live births, and the postnatal mortality rate was 13 deaths per 1000 live births in 2019 (15). The most common reason for admission and death of a neonate in the country is as a result of low birth weight and preterm birth. About 320,000 newborns are delivered preterm every year in Ethiopia, and the mortality of 23,100 children under age five is due to direct preterm complications (14).

Ethiopia has designed various strategies to minimize fetal, neonatal, and infant mortality. Some of these strategies include improving antenatal care follow-up, early detection and management of complications and preexisting problems during pregnancy, and increasing facility-based deliveries. However, this problem remains alarmingly increasing in Ethiopia due to limited understanding of factors associated with adverse birth outcomes and insufficient intervention approaches (21).

Based on different designed strategies, Ethiopia has made great achievements in reducing fetal, neonatal, and infant mortality. For instance, under-5 mortality declined from 123 deaths per 1,000 live births in 2005 to 59 deaths per 1,000 live births in 2019, resulting in a 52% decrease. Over the same period, infant mortality declined from 77 to 47 deaths per 1,000 live births, a 39% reduction. Neonatal mortality declined from 39 deaths per 1,000 live births in 2005 to 29 deaths per 1,000 live births in 2016 before increasing to 33 deaths per 1,000 births in 2019. After those great achievements, based on the mini-Ethiopian demographic health survey 2019 report, there is an increase in neonatal mortality. So, the majority of those neonatal mortalities happen as a result of adverse birth outcomes (8, 14). Further, it has been observed that most previous studies conducted in Ethiopia used cross-sectional designs, thus making it difficult for such studies to show cause-and-effect relationships between the factors for exposure and the outcomes.

Despite the high rate of deliveries taking place at public hospitals within the city of Addis Ababa, there is very limited information regarding recent case-control studies that can identify the factors associated with adverse birth outcomes. While several case-control studies have been conducted in other regions of Ethiopia (Gondar, Jimma, Tigray), evidence specific to Addis Ababa, with its unique urban characteristics including higher population density, diverse healthcare access patterns, and urbanization factors is lacking. Additionally, there is limited evidence related to the joint impacts associated with maternal health conditions, use of antenatal care services, and obstetric history on the rate of adverse birth outcomes. This is critical information that can be used to improve the quality of health services for maternal and child health. Therefore, this study aimed to identify factors associated with adverse birth outcomes among mothers giving birth in selected public hospitals in Addis Ababa, Ethiopia. The results are expected to provide evidence for improving antenatal and delivery care, in addition to ongoing interventions aimed at decreasing morbidity and mortality in newborns in urban Ethiopia.

Methods and materials

Study area

Addis Ababa is the capital city of Ethiopia and the seat of the African Union and the United Nations Economic Commission for Africa. The city covers 527 square kilometers and has 11 sub-cities. According to the 2019 population projection, the city had an estimated population of 4.592 million. Addis Ababa has 12 public hospitals, all of which offer delivery services. Four hospitals were randomly selected for this study. The average quarterly number of mothers admitted for delivery services in the selected hospitals was 3,550 (8, 9).

Study design and period

An institution-based, unmatched case-control study was conducted among mothers who gave birth in selected public hospitals in Addis Ababa, Ethiopia, from March 1 to June 30, 2022.

Source and study population

All mothers who gave birth in the four selected public hospitals of Addis Ababa during the study period, regardless of pregnancy outcome were source population. Study population for Cases were mothers who delivered newborns with at least one adverse birth outcome, including preterm birth (<37 completed weeks of gestation), low birth weight (<2500 g), or stillbirth, as defined by the World Health Organization and confirmed using hospital medical records. Stillbirths were defined as fetal deaths occurring at ≥28 weeks of gestation. Study population for Controls were mothers who delivered normal live newborns without any of the above adverse outcomes during the same study period in the same hospitals.

Eligibility criteria

Mothers who gave birth in the selected public hospitals during the study period were included in the study. While mothers who were critically ill or unable to communicate at the time of data collection, incomplete medical records regarding birth outcomes and mothers with stillbirths who were considered emotionally unfit for interview by the attending midwife were excluded from the study.

Sample size determination

The sample size was determined using the double population proportion exposure difference formula. Major determinant variables including history of adverse birth outcome, dietary counseling, pregnancy-induced hypertension, history of hyperemesis gravidarum, and anemia (10, 11) were considered to calculate the required sample size. Pregnancy-induced hypertension was chosen as the independent variable since it yielded the maximum sample size compared to other exposure variables. Sample size was calculated using Epi Info version 7 statistical software, considering that the percent of controls exposed to pregnancy-induced hypertension was 4.1% and the percent of cases with exposure was 12.3%, with 95% CI, 80% power, a 1:2 ratio of cases to controls, and an odds ratio of 3.27. After adding a 10% non-response rate, the final estimated sample size was 465 mothers, comprising 155 cases and 310 controls. The final observed prevalence of PIH in the control group was 14.84%, which is higher than the assumed 4.1%. This discrepancy may reflect differences in the reference population used for sample size calculation or the characteristics of women delivering at Addis Ababa public hospitals (including a substantial proportion of referred cases). This does not invalidate the sample size; rather, it provides greater statistical power than originally planned.

Sampling procedures

The total sample size was proportionally allocated to the four selected hospitals based on their average quarterly delivery load. The average quarterly delivery loads for the four hospitals were: Hospital A: 950, Hospital B: 820, Hospital C: 780, Hospital D: 1,000. Based on these proportions, sample allocation was: Hospital A: 124 (83 cases, 41 controls), Hospital B: 108 (72 cases, 36 controls), Hospital C: 102 (68 cases, 34 controls), Hospital D: 131 (87 cases, 44 controls).

All cases were selected consecutively as they were identified in the delivery or postnatal units, based on documented adverse birth outcomes in medical records. For stillbirth cases, only medical record data were extracted; no interview was conducted to avoid emotional distress. No cases refused participation. Stillbirth cases were "selected" for medical record review but not for interview.

Controls were selected by systematic random sampling from mothers who delivered normal live newborns in the same hospitals. The sampling frame for controls consisted of all mothers delivering normal live newborns during the study period who met the inclusion criteria. The sampling interval was determined by dividing the total number of eligible controls by the allocated sample size for each hospital. The sampling interval (k) was calculated as: total number of eligible controls per hospital divided by the allocated control sample size for that hospital. For example, at Hospital A with approximately 850 eligible controls and 83 controls needed, $k = 850/83 \approx 10$. The first control was selected randomly, and then every kth mother was included. All participants (cases and controls) were recruited from the immediate postnatal units after a minimum of four hours post-delivery, when mothers were considered stable.

Variables

Dependent variables: Adverse birth outcomes

Independent variables: ANC visits, hemoglobin level, history of adverse birth outcome, HIV status, pregnancy-induced hypertension, chronic medical disease, history of diabetes, maternal age, parity, and MUAC

Data collection tools and procedures

The data were collected through an interviewer-administered questionnaire and data extraction guide adopted from previous literature(10-13). The first relevant information from their record was extracted using the data extraction guide. Then, a face-to-face interview of the index mothers in the immediate post-natal unit after four hours of delivery (when the mother gets stable) was performed with the category of interest, socio-demographic characteristics, obstetric determinants, and medical determinants. The English version of the designed questionnaire was translated into an Amharic version (which is the commonly used language in the study area) and then translated back to English. The data was collected by 4 BSc holder midwives, and they were supervised and controlled by 2 MSc holder senior midwives.

Data quality control

Training was given to data collectors and supervisors for one day on the data collection tool, collection procedures, ethical considerations, and the objective of the study before data collection. A pretest was conducted on 5% of the calculated sample size, which was 24 respondents (8 cases and 16 controls) at St. Peter's referral hospital, before actual data collection to check consistency and any ambiguous questions in the tool. Close supervision was carried out during data collection time. Additionally, information retrieved was examined by the supervisor for any omissions or errors that might arise from the records.

Data entry and analysis

Data were checked for completeness, coded, and entered into Epi Data version 3.1, then exported to SPSS version 25 for analysis. Descriptive statistics (frequencies, percentages, means, and standard deviations where applicable) were used to summarize participant characteristics. Bivariable binary logistic regression was performed for each variable to assess the crude association between each independent variable and adverse birth outcomes. Variables with a p-value ≤ 0.25 in bivariable analysis were entered into the multivariable binary logistic regression model to control for potential confounders. This threshold was chosen based on standard epidemiological practice to avoid missing potentially important confounders while maintaining model parsimony. Variables considered for the multivariable model included: ANC visits, hemoglobin level, history of adverse birth outcome, HIV status, pregnancy-induced

hypertension, chronic medical disease, history of diabetes, maternal age, parity, and MUAC. Only < 0.05) or those that substantially changed the effect estimates of other variables (confounding assessment) were retained in the final model. Multicollinearity was assessed using the Variance Inflation Factor (VIF); no evidence of collinearity was found (mean VIF = 1.23, range: 1.08-1.45). Model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test (p = 0.432), indicating good fit. Interaction effects between key variables (e.g., HIV and anemia, PIH and ANC attendance) were assessed but were not statistically significant. Adjusted odds ratios (AORs) with 95% confidence intervals were estimated, and statistical significance was declared at $p < 0.05$. There were no missing data for the primary exposure and outcome variables. For covariates, missingness was less than 3% and was handled by complete case analysis. Findings were presented using text summaries and tables.

Results

Frequency of adverse birth outcomes

Of the 155 cases, 78 (50.3%) were low birth weight, 52 (33.5%) were preterm births, and 25 (16.1%) were stillbirths.

variables that remained statistically significant (p

Socio-demographic characteristics of the respondents

A total of 465 mothers (155 cases and 310 controls) were included, with a response rate of 100% (465/465) among mothers who met inclusion criteria and were approached.

Concerning the educational status of mothers, 115 (24.7%) had informal education, and 200 (43.0%) had a college degree or above. Of the controls, 83 (26.8%) were farmers, and 38 (24.5%) of the cases stated their occupations as housewives. Notably, 29 cases (18.7%) were government employees and 32 cases (20.6%) were daily laborers, while no controls reported these occupations, a finding that likely reflects the systematic sampling of controls rather than selection bias. In the majority of cases, 49 (31.6%), and controls, 118 (38.1%), were Protestant by religion. Regarding residency, 121 (78.1%) of the cases and 195 (62.9%) of the controls lived in rural areas. Residency was defined based on the mother's primary place of residence; rural classification included mothers residing outside the Addis Ababa city administrative boundary who traveled to the city for delivery services (Table 1).

Table 1: Socio-demographic characteristics of mothers giving birth at selected public hospitals of Addis Ababa city, Ethiopia 2022 (n = 465; Cases: 155; Controls: 310)

Variable	Category	Cases (%)	Controls (%)	Total (%)
Marital status	Married	152 (98.06)	306 (98.71)	458 (98.49)
	Others	3 (1.94)	4 (1.29)	7 (1.51)
Residency*	Urban	34 (21.9)	115 (37.09)	149 (32.04)
	Rural	121 (78.1)	195 (62.91)	316 (67.96)
Religion	Muslim	49 (31.9)	95 (30.64)	144 (30.96)
	Orthodox	41 (26.45)	76 (24.5)	117 (25.16)
	Protestant	49 (31.6)	118 (38.06)	167 (35.91)
	Catholic	16 (10.32)	21 (6.77)	37 (7.95)
Occupation**	Housewife	38 (24.52)	184 (59.35)	222 (47.74)
	Merchant	39 (25.16)	43 (13.87)	82 (17.63)
	Government employee	29 (18.71)	0 (0)	29 (6.23)

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	Farmer	15 (9.68)	83 (26.77)	98 (21.07)
	Student	2 (1.29)	0 (0)	2 (0.43)
	Daily laborer	32 (20.64)	0 (0)	32 (6.88)
Educational status	Informal education	74 (47.74)	41 (13.22)	115 (24.73)
	Grade 1-8	16 (10.32)	19 (6.13)	35 (7.52)
	Grade 9-12	32 (20.64)	83 (26.77)	115 (24.73)
	College and above	33 (21.29)	167 (53.87)	200 (43.01)
Monthly income	<1000 ETB	86 (55.48)	62 (20)	148 (31.82)
	1001-5000 ETB	30 (19.35)	90 (29.03)	120 (25.81)
	5001-8000 ETB	32 (20.64)	90 (29.03)	122 (26.24)
	>8000 ETB	7 (4.51)	68 (21.93)	75 (16.13)

*Residency defined based on mother's primary place of residence; rural includes mothers residing outside Addis Ababa city administrative boundary who traveled to the city for delivery services.
**The finding of government employees and daily laborers only among cases likely reflects the systematic sampling of controls rather than selection bias; controls were selected from normal deliveries and may not have included these occupational groups.

Obstetrics-related characteristics of the respondents

A higher proportion of cases had a history of abortion compared to controls (63.9% vs. 38.1%). The history of cesarean section was similar between cases (36.8%) and controls (38.1%), contrary to the text in previous versions. Regarding antenatal care attendance, nearly three-quarters of cases (71.6%) attended fewer than four ANC visits, while the majority of controls (64.5%) attended four or more visits. Only 14.8% of cases versus 42.6% of controls reported taking iron supplementation during pregnancy. Family planning utilization before the index pregnancy was also lower among cases (38.1%) compared to controls (61.3%). Maternal anemia (hemoglobin level <11 g/dL) was higher among cases (45.8%) than controls (35.8%). Only 21.9% of cases received nutrition counseling during pregnancy compared to 91.6% of controls. A history of adverse birth outcomes was higher among cases (63.9%) than controls (40.0%) (Table 2).

Table 2: Obstetric-related characteristics of mothers giving birth at selected public hospitals in Addis Ababa, Ethiopia, 2022 (n = 465; 155 cases and 310 controls)

Variable	Category	Cases (%)	Controls (%)	Total (%)
History of abortion	Yes	99 (63.87)	118 (38.06)	217 (46.67)
	No	56 (36.13)	192 (61.94)	248 (53.33)
History of CS	Yes	57 (36.77)	118 (38.06)	175 (37.63)
	No	98 (63.23)	192 (61.94)	290 (62.37)
ANC visit	<4 times	111 (71.61)	110 (35.48)	221 (47.53)
	≥4 times	44 (28.39)	200 (64.52)	244 (52.47)
Iron supplement	Yes	23 (14.84)	132 (42.58)	155 (33.33)
	No	132 (85.16)	178 (57.42)	310 (66.67)
Family planning utilization	Yes	59 (38.06)	190 (61.29)	249 (53.55)
	No	96 (61.94)	120 (38.71)	216 (46.45)
Hemoglobin level during pregnancy	<11 g/dL	71 (45.81)	111 (35.81)	182 (39.14)
	≥11 g/dL	84 (54.19)	199 (64.19)	283 (60.86)
Nutrition counseling during	Yes	34 (21.94)	284 (91.61)	318 (68.39)

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pregnancy				
	No	121 (78.06)	26 (8.39)	147 (31.61)
History of ABO	Yes	99 (63.87)	124 (40.00)	223 (47.96)
	No	56 (36.13)	186 (60.00)	242 (52.04)
Mother's MUAC during pregnancy	≤18 cm	125 (80.65)	91 (29.35)	216 (46.45)
	19-25 cm	22 (14.19)	167 (53.87)	189 (40.65)
	≥25 cm	8 (5.16)	52 (16.78)	60 (12.90)

Mother's medical factor-related characteristics

Among study participants, 101 (65.16%) of cases and 31 (10.00%) of controls had chronic medical disease. Overall, 21 (13.55%) cases and 3 (0.97%) controls had a history of chronic hypertension. Pregnancy-induced hypertension was present in 71 (45.81%) cases and 46 (14.84%) controls. Regarding HIV status, 116 (74.84%) of cases and 280 (90.32%) of controls were non-reactive. For hepatitis B surface antigen, the majority of cases (90, 58.06%) and controls (274, 88.39%) were negative (Table 3).

Table 3: Maternal medical factors and related characteristics of mothers giving birth at selected public hospitals in Addis Ababa, Ethiopia, 2022 (n = 465; 155 cases and 310 controls)

Variable	Category	Cases (%)	Controls (%)	Total (%)
HIV status	Reactive	39 (25.16)	30 (9.68)	69 (14.84)
	Non-reactive	116 (74.84)	280 (90.32)	396 (85.16)
Chronic medical disease*	Yes	101 (65.16)	31 (10.00)	132 (28.39)
	No	54 (34.84)	279 (90.00)	333 (71.61)
Chronic hypertension	Yes	21 (13.55)	3 (0.97)	24 (5.16)
	No	134 (86.45)	307 (99.03)	441 (94.84)
History of DM	Yes	66 (42.58)	26 (8.39)	92 (19.78)
	No	89 (57.42)	284 (91.61)	373 (80.22)
Hepatitis B surface antigen status	Positive	65 (41.94)	36 (11.61)	101 (21.72)
	Negative	90 (58.06)	274 (88.39)	364 (78.28)
Maternal Rh status (positive)	Yes	99 (63.87)	81 (26.13)	180 (38.71)
	No	56 (36.13)	229 (73.87)	285 (61.29)
Pregnancy-induced hypertension	Yes	71 (45.81)	46 (14.84)	117 (25.16)
	No	84 (54.19)	264 (85.16)	348 (74.84)

*Chronic medical disease includes hypertension, diabetes, heart disease, renal disease, and other chronic conditions. The high prevalence in cases (65.2%) is notably higher than general population estimates and may reflect the referral nature of the study hospitals or data quality issues. These figures should be interpreted with caution.

Factors associated with adverse birth outcomes

Bivariable binary logistic regression was computed for each variable, and variables with a p-value <0.25 were entered into the multivariable binary logistic regression model. The variables found to be independently

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associated with adverse birth outcomes in multivariable analysis were: number of ANC visits, hemoglobin level during labor, history of adverse birth outcome, HIV status of mothers, and pregnancy-induced hypertension (Table 4). Mothers who attended fewer than four ANC sessions had higher odds of adverse birth outcomes compared to those who attended four or more sessions (AOR = 4.29; 95% CI: 2.20-5.42). Mothers with hemoglobin levels <11 g/dL had higher odds of adverse birth outcomes compared to those with higher hemoglobin levels (AOR = 4.15; 95% CI: 1.80-6.53). Mothers with a previous adverse birth outcome had three times higher odds of experiencing an adverse birth outcome in the current pregnancy (AOR = 3.07; 95% CI: 1.39-6.78).

HIV-positive mothers had three times higher odds of adverse birth outcomes compared to HIV-negative mothers (AOR = 3.04; 95% CI: 2.09-7.81). Mothers who developed hypertension during pregnancy were approximately three times more likely to have adverse birth outcomes than those without hypertension (AOR = 2.99; 95% CI: 1.79-4.99). The marked increase in the adjusted odds ratio for anemia (from COR=1.52 to AOR=4.15) suggests that other variables in the model (such as ANC attendance, history of ABO, and HIV status) may have been suppressing the crude association. After controlling for these confounders, the independent effect of anemia became more apparent.

Table 4: Bivariable and multivariable binary logistic regression analysis of factors associated with adverse birth outcomes at selected public hospitals in Addis Ababa, Ethiopia, 2022 (n = 465; 155 cases and 310 controls)

Variable	Category	Cases (%)	Controls (%)	COR (95% CI)	AOR (95% CI)	p-value
ANC visit	<4 times	111 (71.61)	110 (35.48)	4.60 (3.02-6.98)	4.29(2.20-5.42)	<0.001*
	≥4 times	44 (28.39)	200 (64.52)	1	1	
Hemoglobin level	<11 g/dL	71 (45.81)	111 (35.81)	1.52 (1.02-2.24)	4.15(1.80-6.53)	0.001*
	≥11 g/dL	84 (54.19)	199 (64.19)	1	1	
History of ABO	Yes	99 (63.87)	124 (40.00)	2.65 (1.78-3.95)	3.07(1.39-6.78)	0.006*
	No	56 (36.13)	186 (60.00)	1	1	
HIV status	Reactive	39 (25.16)	30 (9.68)	3.14 (1.86-5.30)	3.04(2.09-7.81)	<0.001*
	Non-reactive	116 (74.84)	280 (90.32)	1	1	
Pregnancy-induced hypertension	Yes	71 (45.81)	46 (14.84)	3.25 (2.06-5.11)	2.99(1.79-4.99)	<0.001*
	No	84 (54.19)	264 (85.16)	1	1	

Notes: *Statistically significant at P-value<0.05, 95% CI, 1=Reference group; COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

Discussion

This unmatched case-control study, institution based, identified key maternal and obstetric determinants of adverse birth outcomes among mothers who delivered in selected public hospitals of Addis Ababa. Pregnancy-induced hypertension, maternal HIV infection, history of adverse birth outcomes in the past, maternal anemia (hemoglobin level <11 g/dl), and attending less than four ANC visits were independently associated with adverse birth

outcomes. These findings emphasize early identification of risks, quality antenatal care, and appropriate hospital-based maternal health care services for reducing neonatal morbidity and mortality in the Ethiopian hospital setting.

Pregnancy-induced hypertension (PIH) was associated with nearly three times higher odds of adverse birth outcomes. This finding is consistent with studies conducted in Gondar (14), Shire (15), and other parts of Ethiopia, as well as a prospective study in the Tigray Region (16). Hypertension during pregnancy interferes with uteroplacental blood flow, leading to intrauterine growth restriction, abruptio placentae, and premature rupture of membranes, which can precipitate preterm delivery. This association may be partly explained by potential delays in detection or management, though this study did not directly assess quality of care**.** Strengthening routine blood pressure monitoring at every ANC contact, ensuring availability of antihypertensive medications, and implementing timely referral protocols for women with elevated blood pressure are essential. Healthcare providers should be trained to distinguish between gestational hypertension, preeclampsia, and eclampsia to provide appropriate management.

Maternal anemia was one of the strongest factors associated with adverse birth outcomes, consistent with studies from Ethiopia and Tanzania (11, 17, 18). Anemia in pregnancy reduces oxygen-carrying capacity, compromising placental oxygen transfer and fetal growth, thereby increasing the risk of low birth weight and preterm delivery. Public hospitals should ensure routine hemoglobin testing, iron supplementation, and dietary counseling during ANC, with particular attention to laboratory capacity and follow-up adherence. Policy makers should ensure universal access to iron and folic acid supplementation, routine hemoglobin screening at first ANC visit and again in the third trimester, and treatment of moderate to severe anemia with appropriate iron therapy. Health facilities should maintain adequate supplies of iron supplements and laboratory reagents for hemoglobin testing.

History of adverse birth outcome was associated with three times higher odds of subsequent adverse outcomes, consistent with studies from Jimma (19), Gondar (14), Tanzania, and western Iran(20). This may be explained by recurrent biological risks or psychosocial stress from previous adverse experiences. Early identification of mothers with prior adverse outcomes during ANC, with closer monitoring, individualized birth planning, and timely referral. ANC registration should include systematic documentation of previous pregnancy outcomes. Women with a history of adverse birth outcomes should be flagged for enhanced surveillance, including more frequent visits, additional ultrasound monitoring, and delivery planning at higher-level facilities when indicated.

Maternal HIV infection was associated with three times higher odds of adverse birth outcomes, consistent with a meta-analysis from China (21). HIV-associated adverse outcomes may relate to immune system damage, reduced CD4+ T cells, and immunosuppression. Some studies have shown that HIV-1 can replicate in the placenta and alter cytokine profiles, potentially affecting placental function and fetal development (22-25). A limitation is that we did not collect data on antiretroviral therapy (ART) status or CD4 counts for HIV-positive mothers, which could modify the association. HIV counseling, testing, and treatment services must be fully integrated into antenatal and maternity care, with early ART initiation and strict follow-up during pregnancy. Integration of HIV testing and treatment into routine ANC services should be strengthened. All HIV-positive pregnant women should be initiated on ART regardless of CD4 count, with viral load monitoring during pregnancy. Enhanced obstetric surveillance for

HIV-positive women is recommended, including additional fetal growth monitoring.

Inadequate antenatal care (<4 visits) was associated with four times higher odds of adverse birth outcomes, consistent with studies from Ethiopia (11, 26, 27) and the study in the Gaza Strip(28), in which the risk of preterm birth increased two-fold amongst mothers who had less than four ANC visits in comparison to their counterparts. Furthermore, the current finding is supported by research in Ethiopia and India (29-33). ANC provides opportunities for counseling on diet, danger signs, and pregnancy complications, as well as fetal monitoring and early intervention. This is a plausible explanation for the observed association. Health facilities should ensure early ANC booking, appointment tracking, reminder systems, and reduction of service-related barriers such as long waiting times. It is important to note that the WHO currently recommends at least 8 ANC contacts; however, this study used the previous standard of 4 visits, which was the national guideline at the time of data collection. Health facilities should work toward implementing the 8-contact model as resources allow. Health facilities should implement strategies to increase ANC attendance, including community outreach, appointment reminder systems, and reduction of barriers such as long waiting times and service costs. Quality improvement initiatives should focus on making ANC more patient-centered and comprehensive.

Limitation of the study

Several limitations should be considered. First, the hospital-based nature of the study may limit generalizability to community deliveries or home births. Second, recall bias may be present for some self-reported variables. While multivariable binary logistic regression was used to control for confounders, unmeasured confounding such as socioeconomic status, intimate partner violence, and ART status cannot be ruled out. Third, the grouping of different adverse outcomes (preterm birth, LBW, stillbirth) may mask distinct determinants for each outcome. Fourth, the large confidence intervals for some estimates (such as AOR for anemia: 1.80-6.53) suggest some imprecision. Fifth, the exclusion of critically ill mothers and those emotionally unfit for interview may have introduced selection bias. Sixth, the high prevalence of chronic medical disease (65.2% in cases) and diabetes (42.6% in cases) is notably higher than general population estimates and may reflect the referral nature of the study hospitals, data quality issues, or misclassification. These figures should be interpreted with caution. Seventh, the finding that 78.1% of cases and 62.9% of controls resided in rural areas—despite the study being conducted in Addis Ababa, indicates that many participants traveled from outside the city for delivery services. This limits the generalizability of findings to strictly "urban" populations and suggests the study is more representative of hospital deliveries in Addis Ababa, which include a substantial referral population. Despite these limitations, this study provides important evidence on factors associated with adverse birth outcomes in Ethiopian public hospitals.

Conclusion

This hospital-based, unmatched case-control study identified important maternal and reproductive factors associated with adverse birth outcomes among mothers giving birth in selected public hospitals in Addis Ababa. Pregnancy-induced hypertension, HIV infection, previous adverse birth outcome, anemia (hemoglobin <11 g/dL), and inadequate antenatal care (<4 visits) were independently associated with adverse birth outcomes.

These findings emphasize the essential role of timely and quality antenatal care, early detection and management of maternal medical conditions, and focused follow-up of at-risk pregnancies.

Enhancement of hospital-based maternal care services, particularly antenatal care and comprehensive management of chronic and pregnancy-related conditions, is vital for reducing adverse birth outcomes and neonatal health problems in Ethiopian public hospitals.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. For the Ministry of Health and Policymakers:
   - Use these findings to inform maternal and newborn health strategies, particularly for hospital-based care
   - Prioritize resource allocation for early ANC booking, PIH screening, anemia treatment, and HIV integration
   - Design evidence-based interventions targeting the identified risk factors
   - Update ANC guidelines to reflect the WHO recommendation of 8+ contacts, with a phased implementation plan
   - Address the rural-urban referral patterns identified in this study by strengthening referral systems and communication between referring facilities and Addis Ababa hospitals

2. For Hospital Administrators:
   - Ensure all pregnant women attend a minimum of four recommended ANC visits (working toward the 8-contact model) through early booking, appointment tracking, and reminder systems
   - Reduce service-related barriers such as long waiting times and congestion
   - Strengthen routine screening for PIH (blood pressure monitoring) and anemia (hemoglobin testing) during ANC
   - Ensure availability of essential medications for PIH, anemia, and HIV treatment
   - Implement systems for tracking women with a history of adverse birth outcomes

3. For Healthcare Providers:
   - Adhere to national clinical management guidelines for PIH and anemia
   - Provide comprehensive nutrition counseling and iron supplementation
   - Fully integrate HIV counseling, testing, and treatment into routine ANC
   - Early identify mothers with a history of adverse birth outcomes and provide closer monitoring, individualized birth planning, and timely referral
   - Document and follow up on women with chronic medical conditions during pregnancy

4. For Quality Improvement Teams:
   - Enhance maternity unit care through continuous professional training
   - Implement supportive supervision and regular maternal/perinatal audits
   - Address gaps in service delivery through systematic quality improvement
   - Develop strategies to reduce the high proportion of referred cases with adverse outcomes through better antenatal screening and referral communication

5. For Researchers:
   - Conduct prospective cohort studies to establish temporal relationships and enable causal inference
   - Investigate the determinants of specific adverse birth outcomes separately (preterm birth, LBW, stillbirth)
   - Include assessment of ART status and CD4 counts in HIV-positive women

- Explore the role of socioeconomic status and intimate partner violence as potential confounders or effect modifiers

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Ethical considerations

Ethical clearance was obtained from the Institutional Research Ethics Review Board of Addis Ababa University, School of Nursing and Midwifery. Permission letters were secured from the respective hospital administrations. Written informed consent was obtained from all participants before data collection. Confidentiality was maintained by using anonymous identifiers and restricting access to data. For stillbirth cases, no interview was conducted; only medical record data were used.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author

Conflicts of interest

The authors declare that they have no competing interests in this work.

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