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Effect of Hypertensive Disorders of Pregnancy (HDP) on maternal and perinatal birth outcomes in Eastern Ethiopia: a prospective cohort study

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Abstract

Background Globally, hypertensive disorders of pregnancy are the major causes of maternal and perinatal morbidity and mortality. In low and middle-income countries, including Ethiopia, studies on the effect of hypertensive disorders of pregnancy on maternal and perinatal birth outcomes are limited.

Objectives The aim of this study was to examine the effect of hypertensive disorders of pregnancy on maternal and perinatal birth outcomes in Eastern Ethiopia.

Methods We employed a prospective cohort study design involving 374 pregnant women, equally divided into hypertensive ((*n* = 187) and normotensive (*n* = 187). Data were collected face to face using an interviewer-administered questionnaire as well as by reviewing the medical records of the mothers. Data analysis was done in STATA Version 17. Binary logistic regression was run to produce risk ratios (relative risk) and 95% confidence intervals along with their *p*-values were calculated in the bivariate and multivariable analyses. Significance was declared at a *P*-value of less than 0.05.

Results Compared with normotensive, women with hypertensive disorder had significantly increased risk of developing preterm birth (cRR = 1.8; 95% CI, 1.5, 2.2), stillbirth (cRR = 1.6; 95% CI, 1.3, 2.02), low birth weight (cRR = 1.9; 95% CI, 1.6, 2.3), and early neonatal death (cRR = 1.7; 95% CI, 1.3, 2.3). Women with hypertensive disorders had 2.6 times (aRR = 2.6, 95% CI; 1.2, 5.7) higher risk of perinatal death, and 1.7 (aRR = 1.7; 95%CI, 1.02, 2.90) times higher risk of cesarean section delivery compared with the normotensive women controlling the other variables.

Conclusion Significant risk of cesarean section delivery, perinatal death, stillbirth, low birth weight delivery, and early neonatal death were reported among women with hypertensive disorders of pregnancy. To minimize the burden of the problem, much has to be done by health care professionals and stakeholders focusing on the identification and proper management of mothers with hypertensive disorders.

Keywords Pregnancy, Hypertensive disorders, Perinatal outcome, West Hararghe, Maternal outcome, Ethiopia

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Introduction

Approximately 500,000 women worldwide lose their lives to pregnancy and delivery complications each year, with the majority of these deaths occurring in low-income nations [1]. One of the main causes of maternal and perinatal death and morbidity during pregnancy is a hypertensive condition [2]. Hypertension during pregnancy is defined as a systolic blood pressure of 140 mmHg or higher and/or a diastolic blood pressure of 90 mmHg or higher on two separate occasions that are at least six hours apart. Pregnancy-related seizures, elevated blood pressure, and protein in the urine are its hallmarks [3].

Hypertensive disorders of pregnancy (HDP) include chronic hypertension, gestational hypertension, preeclampsia, and eclampsia [4], with the prevalence of 5%–10% among pregnant women [5]. The incidence of HDP increased from 16.30 million to 18.08 million, with total increases 10.92% from 1990 to 2019 [6]. According to the WHO estimating that at least one woman dies every seven minutes from complications of HDP [7].

Hypertensive disorders of pregnancy (HDP) accounts for 18% of maternal deaths worldwide and 50% of maternal death in Sub-Saharan Africa [8, 9]. In a similar time period, hypertensive disorders in pregnancy contributed for 19% of maternal deaths in Ethiopia [10]. Preeclampsia and eclampsia alone contributes for 12% of maternal mortality globally and the case fatality rate varies in developing and developed countries [11]. In Ethiopia, preeclampsia and eclampsia contributed for 11% of maternal deaths and 16% of direct maternal mortality [12].

A hypertensive disorder of pregnancy also contributes for a significant perinatal morbidities and mortalities [13]. Previous studies showed that the risk of fetal and neonatal deaths, preterm birth and admission to a neonatal intensive care unit (NICU) were higher among hypertensive disorders of pregnancy cases as compared with their normotensive counterparts [14]. It estimated that HDP precedes 15% of maternal death worldwide [15]. In developing countries 23.6% of perinatal mortality was caused by hypertensive disorders of pregnancy [16]. For instance, perinatal mortality rate among women with hypertensive disorders of pregnancy was found to be 317/1000 births in Ethiopia. Perinatal mortality is three to five folds higher in women with preeclampsia/eclampsia syndrome as compared to those without the disorders [17]. The Ethiopian ministry of health together with different stakeholder and partners has implemented various strategies to improve maternal and newborn health through increasing availability and easier access to emergency obstetric services. Expansion of health facilities, increased availability of supplies and deployment of appropriately skilled health professionals were among the strategies [18].

Despite the fact maternal and perinatal morbidity and mortality remained high [19, 20] and hypertensive disorders of pregnancy is considered to contribute the major share for this burden [19]. In Ethiopia, studies on the effect of hypertensive disorders of pregnancy on maternal and perinatal birth outcomes are limited. Furthermore, almost all of the studies reviewed employed either cross sectional study or case control study designs and mainly data were obtained retrospectively. In addition, previous studies mainly focused on estimating the maternal and perinatal outcomes among women with hypertensive disorders without comparing with their counterpart (a control group).

However, this study was applied prospective cohort study design and matching criteria to identify normotensive women this could be enhance the comparability of the outcomes to obtain robust evidence on the real variation regarding maternal as well as perinatal birth outcomes among mothers with hypertensive and without hypertensive disorders in the study area. Furthermore, investigating this area of study will help policy makers and programmers to have a clear picture about the effect of HDP on adverse maternal and perinatal outcomes to make an evidence-based decision, to develop appropriate screening and treatment guidelines, design prevention and control mechanisms for hypertensive disorders of pregnancy. Likewise, it will be important to improve the quality of services being given for women with hypertensive disorders in health facilities.

Methods

Study design, setting, and period

This prospective cohort study design was conducted in the west Hararghe zone, Oromia Regional State, Eastern Ethiopia. Chiro town is the capital city of the zone and is located 326 km from Addis Ababa in the eastern direction on the main roads to Harar and Dire Dawa. The west Hararghe zone has 18 woredas and 4 towns. The total projected population of the zone was 2,725,156 in 2022, of which 1,390,721 were males and were 1,334,435 females. Reproductive age group females (15–49 years) comprised 23.5% of the population. The expected number of deliveries in the hospital was around 78,398 per year. In the zone there are 5 primary hospitals and 2 general hospitals that are run and owned by the government [21].

A package of comprehensive care and management is given in hospitals where there are materials and equipment to diagnose and treat the problem and there are senior professionals (obstetricians) who can provide comprehensive care whereas the lower health facilities,

such as health centers provide only the primary care, so a mother with a severe form of the hypertensive disorder is supposed to be referred to the higher level, which makes the follow-up interrupted. Therefore, the presence of obstetricians and the capacity of health facilities to provide comprehensive care were taken as criteria to include in the study. Based on these criteria, a study was conducted in all public hospitals of the West Hararghe zone namely Chiro Hospital, Gelamso Hospital, Hirna Hospital, Burka Dimtu, Mechara, Bedessa Hospital and Asebot Hospitals. The study was conducted from February 2023 to May 30, 2024.

Study participants

All pregnant women who attended antenatal care clinics in public hospitals of the West Hararghe zone were the source of the population. Women were screened by obstetricians for their status of hypertensive disorders of pregnancy, and those with the diagnosis of the specific hypertensive disorders of pregnancy were considered as exposed, while those without it were taken as unexposed or control. Both groups of women were included in the study after 20 weeks of gestation and followed until 7 days postpartum [22]. Hypertensive disorders of pregnancy can be developed in the antepartum, intrapartum, or postpartum phases, but for this study, only the antepartum hypertensive disorders were included. For each exposed pregnant women, one unexposed women (control) matched by parity was enrolled in the follow-up in the same health facility. Maternal and perinatal outcomes were compared between the two groups at the end of the follow-up period. Maternal outcomes include maternal death and maternal complications (cesarean section birth, induction, postpartum hemorrhage, abruptio placentae, and antepartum hemorrhage). Likewise, perinatal outcomes include perinatal death (stillbirth and early neonatal death), preterm birth, low birth weight, low Apgar score, and ICU admission.

Inclusion and exclusion criteria

Pregnant women who attended antenatal clinics in the hospitals whose gestational age was 20 weeks and above and who were diagnosed to have hypertensive disorders of pregnancy by an obstetrician in the antepartum period were included as exposed participants, and women without hypertensive disorders during the same period were also enrolled as non-exposed participants. In addition, pregnant women who were able to provide informed consent and participate in interviews and prospective follow-up were included in the study.

Severely critically ill women who could not give consent, women who could not respond to the interview, pregnant women likely to be lost to follow-up (e.g., planning to move, unwilling to return), and women with twins (to minimize confounding and ensure a homogenous study population) were excluded at the time of enrollment. Pregnant women who were normotensive upon enrollment but developed hypertensive disorder of pregnancy solely during the intrapartum or postpartum periods were excluded from the final analysis.

Sample size determination

A double population proportion formula was used to calculate the sample size from maternal and perinatal outcomes variables among hypertensive and normotensive mothers; the number of exposed and unexposed mothers was calculated using Epi Info 7 Stat Calc for a cohort study based on the following assumptions: Two-sided confidence level = 95%, Power = 80%, ratio (unexposed: exposed) = 1, The proportion of low birth weight outcomes (16.1%) in the unexposed group and 6% in the exposed group was taken from a previous study [1] (Table 1). With the consideration of a 10% lost to follow up, a total of 374 study participants (187 participants with hypertensive disorder and 187 normotensive participants) were included in this study.

Sampling procedures

All of public hospitals providing maternal health services like antenatal care, delivery and postnatal care services in West Hararghe Zone, purposively included based on availability of the obstetrician and gynecologist professionals. All exposed cases that fulfilled the defined criteria was consecutively included until the desired sample size was obtained whereas the controls/unexposed women was selected using a simple random sampling technique from the available controls next to the enrollment of the women with hypertensive disorders. Mothers who was diagnosed with hypertensive disorders of pregnancy with their non-hypertensive pairs was enrolled in the antenatal clinic. Then, they should be followed until delivery and the first 7 days postpartum.

Table 1 Sample size calculations for cohort study

Exposure variable	Proportion among exposed (P1)	Proportion among unexposed (P2)	Ratio of exposed to unexposed (r)	Total sample size (n1 + n2)
Low Birth Weight	16.1%	6%	1:1	340
Preterm birth	31.4%	14.3%	1:1	210

Data collection tools and procedures

Structured questionnaire and checklist was developed following a thorough review of literatures from different sources including the international guidelines, WHO survey tools, previous research [19, 23–29]. The questionnaire was prepared in English and translated into the local language, Afaan Oromo and back to English by independent language experts for consistency. The data collection tool contained variables mainly on socio-demographic characteristics, obstetric history, current pregnancy condition, birth outcomes and neonatal conditions.

Data was collected by seven bachelor's degree holder nurses/midwives and supervised by 4 master's degree holder health professionals. Training and orientation was given for data collectors and supervisors regarding to the objectives of the study, ethical issues, inclusion criteria of the study, follow up procedures of the study and overall the content of the questionnaire and its administration.

The recruitment of study participant who fulfill the inclusion criteria and at 20 weeks and above of their gestational age during antenatal care was carried out from February 1 to November 30/2023. The follow-up period may be varying between participants depending on the time of enrollment to the study and the gestational age at enrollment. However, the overall follow up period was from February 1/2023 to May 30/2024. All selected women was followed through pregnancy, delivery and early postpartum period to assess adverse maternal and perinatal outcomes of HDP. The follow up was made by communicating with the health care professionals, heath extension workers and the client themselves. To easily trace the mothers in the follow up, detailed address was properly recorded.

Data was collected face to face using an interviewer administered pretested questionnaire as well as by reviewing medical records of mothers to extract relevant laboratory, clinical and obstetrics variables. Data regarding maternal socio-demographic characteristics, medical and obstetric history using a face-to- face interviewer-administered pretested questionnaire and hypertensive disorders in pregnancy status using medical records was collected during enrollment. At the second phase within 24 h of delivery, information about the adverse maternal and perinatal outcomes was collected from medical records. During the third phase within the postnatal period follow up to 7 days. Close supervision and checking of filled-in questionnaires was done by the supervisors deployed with the data collectors. The overall data collection process was coordinated and supervised by the principal investigator.

Dependent variables

Maternal adverse outcomes and perinatal adverse outcomes.

Independent variables

The independent variables for this cohort study design include socio-demographic, obstetrics, medical, personal variables.

Operational definitions

Gestational hypertension- systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg measured on two occasions at least 6 h apart after twenty weeks of gestation in the absence of proteinuria or other systemic symptoms [24].

Preeclampsia- characterized by new onset of hypertension after 20 weeks gestation (systolic blood pressure ≥ 140 mmHg and/or diastolic BP ≥ 90) mmHg and proteinuria. However, in the absence of proteinuria other manifestations such thrombocytopenia (platelet count less than 100,000/microliter), impaired liver function (elevated blood levels of liver transaminases to twice the normal concentration), the new development of renal insufficiency (elevated serum creatinine greater than 1.1 mg/dl or a doubling of serum creatinine in the absence of other renal disease), pulmonary edema, or new onset cerebral or visual disturbances are used to diagnose the case [24].

Eclampsia- characterized by new onset grand mal seizures (convulsion) in a woman with preeclampsia [30].

Proteinuria- a dipstick result of 1 + and above in a qualitative measurement [24].

Definition of outcomes

Maternal adverse outcomes- include at least one of these outcomes (antepartum hemorrhage, postpartum hemorrhage, cesarean section, maternal death, preterm birth).

Adverse neonatal outcome was defined as a newborn with the occurrence at least one of these outcomes (stillbirth, neonatal death, low birth weight, low Apgar score, ICU admission).

Data quality assurance

The questionnaire was prepared in English version and translated in to Afaan Oromo (local language) by experts. Data collectors with a similar previous experience was recruited and trained for 3 days on the purpose and procedure of the study as well as on the meaning and essence of the study tools. In addition, it was pre-tested on 10% of the calculated sample size in institutions (Badesa Hospital) not selected in the

study two weeks proceedings the actual data collection period. Additional adjustment was made in terminologies, sequence of questions, meaning and so on accordingly. The data collection process was checked by the supervisors on daily basis for completeness, inconsistencies and errors. Also, the principal investigator was closely followed the supervisors and data collectors. Finally, the collected data were carefully handled with maximum security; a questionnaire was kept in a locked cabinet.

Data processing and analysis

Data entry was coded and entered into Epi-data 3.2 software and analysis was done in STATA Version 17. Descriptive statistics, frequencies and percentage for categorical variable and summary statistics for continuous data (mean with standard deviation in normally distributed data or median with IQR if the data was not normally distributed) was used to characterize the study population. The normality distribution test was done using the Kolmogorov–Smirnov test and we considered as normally distributed if p-value >0.05. Independent t-test was used to assess the mean difference between groups. Besides, the different maternal and perinatal birth outcomes was compared between the hypertensive and normotensive women (exposed and unexposed women). Binary logistic regression was run to produce risk ratio (relative risk) and crude relative risk and their 95% confidence intervals along with their p-values was calculated in the bivariate analysis. In multivariable analysis, variables with a P-value of 0.2 and less in the bivariate analysis was included to adjust confounders and to get the independent effect of hypertensive disorders of pregnancy on the different adverse birth outcomes. In both cases significance was declared at P-value less than 0.05. The overall findings were presented in texts, tables and figures.

Results

Socio- demographic characteristics of study participants

Of the initially enrolled 374 pregnant women, a response rate of 95% (n= 356, with 178 in each of the normotensive and hypertensive groups) was achieved. The remaining 19 participants (approximately 5%) were excluded from the final analysis due to the development of HDP solely during the intrapartum and postpartum period (n= 8) or being lost to follow-up (n= 10).

Among the mothers with hypertensive diseases, the distribution was as follows: 50 (28.1%) had gestational hypertension, 10 (5.6%) had chronic hypertension, 26 (14.6%) had mild preeclampsia, 75 (42.1%) had severe preeclampsia, 12 (6.7%) had eclampsia, and 5 (2.8%) had chronic hypertension with additional preeclampsia.

The mean age (SD) of all respondents was 26.8 (5.4) years, with women in the hypertensive group averaging 26.5 (5.6) years and women in the normotensive group averaging 27.0 (5.1) years old. The age range was 15 to 46, with the majority between 20 and 34. Additionally, over 92% of respondents were married and considered Muslim (Table 2).

Table 2 Socio-demographic frequency distribution of hypertensive and normotensive pregnant women in eastern Ethiopia (N= 356)

Variables	Normotensive N (%)	HDP N (%)	*P*-value
Residence			
Urban	77(43.3)	54(30.3)	0.011
Rural	101(56.7)	124(69.7)	
Age category			
< 20	23(12.9)	25(14.0)	0.710
20–34	140(78.7)	134(75.3)	
> 34	15(8.4)	19(10.7)	
Mean age (SD) in years	27(5.1)	26.5(5.6)	0.328
Mean pre-pregnancy weight(SD)	51(6.6)	53.8(8.3)	≤ 0.001
Parity			
Primipara	45(25.3)	68(38.2)	0.009
Multipara	133(74.7)	110(61.8)	
Marital status			
Married	167 (93.8)	168(94.4)	0.82
Unmarried	11(6.2)	10(5.6)	
Religion			
Muslim	166(93.3)	163(91.6)	0.548
Christian	12(6.7)	15(8.4)	
Ethnicity			
Oroma	166(93.3)	167(93.8)	0.829
Amhara	12(6.7)	11(6.2)	
Woman's educational status			
No education	45(25.3)	53(29.8)	0.835
Read and write	27(15.2)	21(11.8)	
Primary	45(25.3)	45(25.3)	
Secondary and higher	61(34.3)	59(33.1)	
Occupation			
Housewife Gov't employee Nongovernmental employee Private Organization	130(73) 31(17.4) 3(1.7) 14(7.8)	125(70.2) 31(17.4) 7(3.9) 15(8.4)	0.80
Husband's educational status(N= 335)			
No education Read and write Primary Secondary and higher	24(14.3) 45(26.8) 28(16.7) 71(42.2)	28(16.8) 38(22.6) 29(17.4) 72(43.1)	0.728

Comparison of adverse maternal and perinatal outcomes

Women with hypertension are more likely to experience preterm birth, cesarean section delivery, antepartum hemorrhage, and postnatal hemorrhage. Conversely, women without hypertensive disorders are more likely to have a spontaneous vaginal delivery (Fig. 1).

The mean (SD) gestational age at birth was 36.6 (3.3) weeks in the hypertensive mothers and 38.4 (2.1) in the women without hypertensive disorders ($P< 0.001$). On average, women with hypertension give birth 1.5 weeks earlier than normotensive women. Maternal pregnancy or delivery complications were examined in the two groups and it was found that 12 (6.7%) and 24 (13.5%) women in the normotensive and hypertensive groups, respectively were noted ($P= 0.023$). In this study, two women died and both were among the cases of hypertensive diseases, particularly in the category of severe preeclampsia. It was found that the cesarean section rate was almost twice as high in the exposed group compared to the unexposed mothers (36 (20.2%) vs. 19 (10.7%), $P= 0.004$). Likewise, 39 (21.9%) women in the hypertensive category had undergone labour induction, while only 9 (5.1%) normotensive women had undergone labour induction (Table 3).

The incidences of adverse perinatal outcomes were higher among women with HDP than women with normotensive. The rate of early neonatal death was significantly higher in mothers with hypertension than in mothers without hypertension (6.4% vs. 1.2%, $P< 0.001$). The rate of preterm birth was also higher in the high blood pressure group than normotensive 43.3% vs 15.2%, $P< 0.001$), with a preterm birth 4.8 times more likely to occur at 34 to 37 weeks or less than 34 weeks. In addition, the mean birth weight of babies born from hypertensive mothers was significantly lower than that of normotensive mothers (2.7 (0.6) kg versus 3.1 (0.5) kg). Low birth weight babies of mothers with HDP than normotensive were 44 (28%) and 11(6.4%). The incidence of stillbirth was higher among newborn babies delivered from women with HDP than normotensive women (21% versus 6%). Similarly, the babies'first and fifth-minute low APGAR scores were higher among women with HDP than normotensive women (28.1% versus 10.1%), (21.9% versus 6.7%) respectively. Overall, the Incidence of all adverse perinatal outcomes between HDP and normotensive women has a statistically significant difference between both groups (Table 2).

Effect HDP on adverse birth outcome

The risk estimates for adverse maternal and perinatal outcomes of women with HDP compared with women with normotensive. The risk of cesarean delivery was 90% higher in women with hypertensive disorders (cRR 1.9, 95% CI; 1.1, 3.2) compared to normotensive women. Further analyses were performed to determine the effects of the different hypertensive diseases. Therefore, preeclampsia and eclampsia cases had 2.3 and 4.3 times higher risk of undergoing cesarean section, respectively, compared to women without hypertensive diseases. Women in whom labour was induced before delivery had an 80% increased risk of cesarean section (cRR 1.8, 955 CI; 1.02, 3.1) compared to women in whom labour was induced spontaneously. In this study, variables such as attendance status, age, timing of first ANC, gestational diabetes mellitus, antepartum bleeding, and preterm birth were not risk factors for cesarean section (Table 4).

Mothers with hypertensive disorders exhibited a 90% increase in the risk of adverse neonatal outcomes compared to their normotensive counterparts. In bivariate analysis, perinatal mortality differed significantly between normotensive and hypertensive mothers. Hypertensive mothers had a 3.8 times higher risk of death in the late

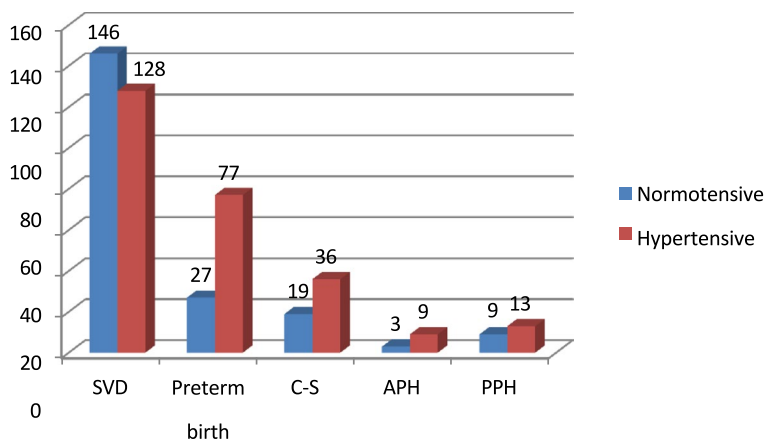

Fig. 1 Pregnancy outcomes among hypertensive and normotensive women in public hospitals of Eastern Ethiopia

Table 3 Adverse maternal and perinatal outcomes of women with HDP compared to women with Normotensive in n public hospital of Eastern Ethiopia

Pregnancy characteristics and birth outcomes	Normotensive N (%)	HDP N (%)	RR(95% CI)	*P*-value
Maternal complications				
Yes	12(6.7)	23(13.5)	1.4(1.04, 1.7)	0.023
No	166(93.3)	155(86.5)	1.0	
GA at birth in weeks				
< 34	8 (4.5)	26(14.6)	4.8(2.1,11.2)	< 0.001
34–37	19(10.7)	51(28.7)	4.0(2.2,7.2)	< 0.001
≥ 37	151(84.8)	101(56.7)	1.0	
Mean GA(SD) at birth in weeks	38.4(2.0)	36.6(3.3)	0.9(0.9, 1.01)	0.275
Onset of labour				
Spontaneous	169(94.9)	139(78.1)	1.0	< 0.001
Induced	9(5.1)	39(21.9)	1.8 (1.5, 2.16)	
Delivery				
Spontaneous vaginal delivery (SVD)	146(82.0)	128(71.9)	1.0	0.004
Cesarean section (CS) Instrumental	19(10.7)	36(20.2)	1.4(1.1, 1.7)	0.59
	13(7.3)	14(7.9)	1.1(0.7, 1.6)	
Preterm birth				
Yes	27 (15.2)	77(43.3)	1.8(1.5, 2.2)	< 0.001
No	151 (84.8)	101(56.7)	1.0	
Apgar score (< 7) at 1 min				
Yes	18(10.1)	51(28.6)	1.6(1.4, 2.0)	< 0.001
No	160(89.9)	127(71.4)	1.0	
Apgar score (< 7) at 5 min				
Yes	12(6.7)	39(21.9)	1.6(1.4, 2.0)	< 0.001
No	166(93.3)	139(78.1)	1.0	
Birth weight in grams				
< 2500	11(6.4)	44(28.0)	1.9 (1.6, 2.3)	< 0.001
≥ 2500	161(93.6)	113(72.0)	1.0	
Mean birth weight (SD) in Kg	3.1(0.5)	2.7(0.6)	0.7(0.6, 0.8)	< 0.001
ICU admission				
Yes	4(2.3)	27(17.2)	1.9 (1.6, 2.4)	< 0.001
No	168(97.7)	130(82.8)	1.0	
Perinatal mortality				
Yes	8(4.5)	31(17.4)	1.7(1.4, 2.0)	< 0.001
No	170(95.5)	147(82.6)	1.0	
Stillbirth				
Yes	6 (3.4)	21(11.8)	1.6(1.3, 2.05)	< 0.001
No	172(96.6)	157(88.2)	1.0	
Early neonatal death				
Yes	2(1.2)	10(6.4)	1.7(1.3, 2.3)	< 0.001
No	170(98.8)	147(93.6)	1.0	

fetal or early newborn period compared to normotensive mothers (cRR = 3.895% CI; 1.8, 8.2). Furthermore, additional analysis was conducted in order to determine whether there are differences between the various forms of hypertensive diseases of pregnancy and the normotensive as a reference category. Preeclampsia, eclampsia, and preeclampsia with chronic hypertension differed considerably from normotensive women ($P < 0.001$, 0.008, and 0.011, respectively), although there was no difference when compared to gestational hypertension. In addition, gestational diabetes mellitus and premature birth were associated with perinatal death (Table 5).

Table 4 Bivariate analysis on the effect of hypertensive disorders of pregnancy on Cesarean Section in Public Hospitals in Eastern Ethiopia, 2024

Variables	Cesarean section		RR (95%, CI)	*P*-value
	Yes N (%)	No N (%)		
Status of mother Normotensive Hypertensive	19(10.7) 36(20.2)	159(89.3) 142(79.8)	1.0 1.9(1.1, 3.2)	0.015*
Type of HDP				
Normotensive	19(10.7)	159(89.3)	1.0	
GHTN	4(8)	46(92)	0.7(0.3, 2.1)	0.584
Preeclampsia	25(24.7)	76(75.3)	2.3(1.3, 4.0)	0.002*
Eclampsia	6(46.2)	7(53.8)	4.3(2.1, 8.9)	≤ 0.001*
CHTN/CHTNsuperimposed	1(7.1)	13(92.9)	0.7(0.1, 4.6)	0.684
Attendance status				
Referred	14(16.7)	70(83.3)	1.1(0.6, 1.9)	0.723
Not referred	41(15.1)	231(84.9)	1.0	
Mean (SD) age	27.0(6.6)	26.7(5.2)	1.01(0.9, 1.05)	0.686
Time at first ANC				
First trimester	3(9.4)	29(90.6)	1.0	
Second trimester	47(16.5)	237(83.5)	1.7(0.6, 5.3)	0.315
Third trimester	5(12.5)	35(87.5)	1.3(0.3, 5.1)	0.677
APH				
Yes	4(33.3)	8(66.7)	2.4(0.9, 5.2)	0.058*
No	51(14.8)	293(85.2)	1.0	
Gestational Diabetes mellitus				
Yes	2(18.2)	9(81.8)	1.2(0.3, 4.2)	0.796
No	53(15.4)	292(84.6)	1.0	
Preterm birth				
Yes	17(16.4)	87(83.6)	1.08(0.6, 1.8)	0.763
No	38(15.1)	214(84.9)	1.0	
Initiation of labour				
Spontaneous	43(14)	265(86)	1.0	
Induced	12(25)	36(75)	1.8(1.02, 3.1)	0.043*

*indicates significance level at $P < 0.05$

The effect of hypertensive disorders on cesarean delivery and perinatal death

In order to investigate the independent effect of hypertension problems by controlling for potential confounders, variables identified in the bivariate analysis as being linked to unfavorable maternal and perinatal outcomes were added to the multivariable logistic regression analysis. Accordingly, when all other factors were held constant, women with hypertension disorders were 70% more likely to have a cesarean delivery (aRR = 1.7, 95% CI; 1.02, 2.9) than those with normotension. Furthermore, compared to normotensive women, women with hypertension disorders had a 2.6-fold (aRR = 2.6, 95% CI; 1.2, 5.7) increased risk of perinatal death (Table 6).

Discussion

This prospective cohort study examined the effect of hypertensive disorders of pregnancy on maternal and perinatal birth outcomes. In our findings, the incidences of adverse maternal and perinatal outcomes such as preterm birth, Induction of labour, cesarean section, LBW, stillbirth, and perinatal mortality were higher among women with HDP than women with normotensive.

Delivery at an earlier gestational age carries the risk of variable maternal and perinatal adverse birth outcomes associated with preterm birth. The better the outcome of delivery, the closer the mother gets to her term gestational age. In this study, the average gestational age at birth was 1.5 weeks shorter in women with hypertension compared to normotensive women. This finding is consistent with a study in China in which women with severe preeclampsia gave birth at a gestational age 0.6 weeks shorter than normotensive women [25]. This finding suggests that if the condition deteriorates due to maternal risk, there is insufficient time to prolong the pregnancy for fetal maturation. Considering only women with hypertensive diseases, the gestational age at birth was almost the same as in a previous study in Pakistan which was 37.37 ± 2.25 weeks [26]. However, preterm birth is the most common cause of death in children, causing nearly 18 deaths per 1000 live births worldwide [31]. Therefore, prevention and treatment of hypertensive disorders of pregnancy should become a priority to accelerate progress in neonatal survival.

In the current research, the induction of labour was significantly higher in hypertensive disorders of pregnancy than in normotensive women (21.9% vs. 5.1% $P < 0.001$), which was lower than the 44.3% reported in the previous study in Addis Ababa in HDP cases [27]. The uterus exhibits both physiological and mechanical resistance to contractions and the initiation of labor throughout the early stages of pregnancy.

In our study, the number of low birth weight babies was higher in HDP mothers than in normotensive mothers: 44 (28%) and 11 (6.4%), respectively. Likewise, the incidence of stillbirth was higher in neonates delivered to women with HDP than in normotensive women (21% versus 6%). This finding was lower than some studies in northwest Tigray Ethiopia (36.8% of LBW versus 36.8% of stillbirths among all HDP cases). The results of this research indicate that hypertensive disorders of pregnancy independently confer an increased risk of adverse perinatal outcomes compared to normotensive pregnant women.

We found that preterm birth occurred in 15.2% of normotensive women and 43.3% of hypertensive women. This result was comparable to the study conducted in portions of Ethiopia, Tigray region (40.8%), Nekemte

Table 5 Bivariate analysis on the effect of hypertensive disorders of pregnancy on perinatal mortality among mothers in public hospitals of Eastern Ethiopia

Variables	Perinatal death		RR (95%, CI)	*P*-value
	Yes, N (%)	No, N (%)		
Status of mother				
Normotensive Hypertensive	8(4.5) 31(17.4)	170(95.5) 147(82.6)	1.0 3.8(1.8, 8.2)	< 0.001*
Type of HDP				
Normotensive	8(4.5)	170(95.5)	1.0	
GHTN	4(8)	46(92)	1.7 (0.6, 5.6)	0.329
Preeclampsia	21(20.8)	80(79.2)	4.6(2.1, 10.0)	< 0.001*
Eclampsia	3(23.1)	10(76.9)	5.1(1.5, 17.0)	0.008*
CHTN/CHTNsuperimposed	3(21.4)	11(78.6)	4.7(1.4 15.9)	0.011*
Residence				
Urban	14(10.7)	117(89.3)	1.0	0.9
Rural	25(11.1)	200(88.9)	1.03(0.6, 1.9)	
Attendance status				
Referred Not referred	12(14.3) 27(9.9)	72(85.7) 245(90.1)	1.4(0.7, 2.7) 1.0	0.26
Parity				
`Primipara	12(10.6)	101(89.4)	0.9(0.5, 1.8)	0.890
Multipara	27(11.1)	216(88.9)	1.0	
Mean (SD) age	25.7(5.1)	27(5.4)	0.9(0.9, 1.02)	0.2*
Mean (SD) Pre-pregnancy weight	53.5(9.9)	52.3(7.3)	1.01(0.9,1.06)	0.37
Time at first ANC				
First trimester	1(3.1)	31(96.8)	1.0	0.18
Second trimester	33(11.6)	251(88.4)	3.7(0.5,26.2)	0.19
Third trimester	5(12.5)	35(87.5)	4.0(0.5, 32.5)	
Anemia				
Yes	4(8.5)	43(91.5)	0.7(0.3, 2.0)	0.57
No	35(11.3)	274(88.7)	1.0	
APH				
Yes	1(8.3)	11(91.7)	0.7 (0.11, 5.0)	0.7
No	38(11.0)	306(89)	1.0	
BMI category				
< 18.5	14(12.7)	96(87.3)	0.7(0.2, 2.2)	0.37
18.5–24.9	20(9.3)	196(90.7)	0.5(0.1, 1.4)	0.57
≥ 25	5(16.7)	25(83.3)	1.0	
GDM				
Yes	4(36.4)	7 (63.6)	3.5(1.5, 8.3)	0.003*
No	35(10.1)	310(89.9)	1.0	
Preterm birth				
Yes	24(23.1)	80(76.9)	3.8(2.1, 7.0)	< 0.001*
No	15(6.0)	237(94.0)	1.0	

*indicates significance level at $P < 0.05$

(41.2%) and Addis Ababa (48.6%) all cases of HDP [27]. The similarity in the prevalence of preterm birth across studies may be due to the similar quality of antenatal care and the same guidelines for the treatment of HDP in the respective areas. In contrast, it was higher than in a study conducted in Ghana (21.7%), India (24.6%) and the USA (10.4%) [29]. The difference could be due to the quality of ANC services and the different management policies in each country.

Table 6 Multivariable analysis for the effect of hypertensive disorders on adverse pregnancy outcomes in Eastern Ethiopia, 2024

Pregnancy and delivery outcomes	Crude RR (95%CI)	*P*-value	Adjusted RR (95%CI)	*P*-value
Cesarean section				
Hypertensive disorders of pregnancy	1.9(1.1, 3.2)	0.015	1.7(1.02, 2.9)	0.041*
Presence of antepartum hemorrhage	2.4(0.9, 5.2)	0.058	1.8(0.8, 4.2)	0.149
Induced labour	1.8(1.02, 3.1)	0.043	1.4(0.8, 2.5)	0.248
Perinatal death				
Hypertensive disorder of pregnancy	3.8(1.8, 8.2)	< 0.001	2.6 (1.2, 5.7)	0.017*
Age	0.9(0.9, 1.02)	0.2	0.9 (0.93, 1.04)	0.686
Gestational DM	3.5(1.5, 8.3)	0.003	2.3(1.02, 5.1)	0.043*
Preterm birth	3.8(2.1, 7.0)	< 0.001	2.7(1.5, 5.2)	0.001*

*indicates significance level at $P < 0.05$

The same report was also found from China, where there was no association between the different types of hypertensive disorders of pregnancy and the risk of preterm birth [25]. This could also be justified by the fact that women in developing countries do not strictly follow prenatal care and the care itself is not up to standard. As a result, prevention, early diagnosis and treatment of obstetric complications, including hypertensive disorders of pregnancy, are not effective, which in turn leads to early termination of pregnancy to save the mother.

Cesarean section rate was found to be 20.2% among the hypertensive group compared to 10.7% among the normotensive group. This finding was much lower than a study in China, where the cesarean section delivery rate was 45.7% in normotensive women and 55.7% in women with hypertensive disorders [30]. Another study in Addis Ababa on cases of hypertensive disorders of pregnancy also reported a caesarean section rate of 44.3% [27], which is much higher than the 20.2% of the current report. This may be due to clinicians awaiting an anticipated delivery, considering the negative consequences of a cesarean section.

In multivariable analysis, the risk of cesarean delivery was 70% higher in women with hypertensive disorders (aRR 1.7, 95% CI; 1.02, 2.9) compared to normotensive women. A study in Pakistan reported no significant difference between hypertensive disease pregnancy groups in cesarean section rates [26]. On the other hand it was in line with a study in USA in which cesarean delivery was significantly increased among the hypertensive group [29].The ultimate treatment of hypertensive disorders of pregnancy is delivering the baby [1]. Thus, it is obvious that pregnant women who developed severe preeclampsia and eclampsia would have higher chance of undergoing cesarean section as it would be a risk for both the mother and the fetus if it is allowed to continue. This is to mean that the difference in the rate of cesarean section mainly depends on the type or severity of hypertensive disorder of pregnancy.

The present investigation also found that perinatal mortality in normotensive and hypertensive women was 4.5% and 17.4% respectively occurred and the strongest independent predictor of adverse events of perinatal outcome. The current study showed that mothers with hypertensive disorders had a 2.6-fold higher risk of perinatal mortality compared to normotensive mothers (aRR 2.6, 95% CI; 1.2, 5.7). In addition, gestational diabetes mellitus and preterm birth were significant predictors of perinatal death. This finding was higher than the study conducted in Ethiopia (Mettu 12.04% and Tigray region 15%). The discrepancy could also be due to differences in the level of care in this setting, which serves as a general hospital rather than a referral hospital, socioeconomic factors, and a small sample size recruited from others. It calls for strengthening maternal and newborn health care to achieve the global and national SDG target plan by focusing the prevention and treatment strategy of HDP and other predictors of perinatal mortality such as gestational diabetes mellitus and preterm birth.

Strengths and limitations of the study

The prospective cohort design represents a key strength of this investigation, facilitating the establishment of temporal relationships between antepartum hypertensive disorders of pregnancy (HDP) and the observed outcomes, thereby mitigating the potential for recall bias inherent in retrospective study designs. Conversely, a notable limitation of the current research was the aggregation of various HDP classifications into a single category for analysis, which may have obscured the potentially distinct effects of specific subtypes, such as gestational hypertension, preeclampsia, and eclampsia, on the examined maternal and perinatal outcomes. Moreover, the exclusion of twin pregnancies, while intended to reduce confounding variables associated

with multiple gestations, restricts the generalizability of our findings to this population recognized to exhibit an elevated risk for HDP. Lastly, the study's focus solely on antepartum HDP means that the impact of hypertensive disorders developing during the intrapartum or postpartum periods was not evaluated, thus limiting the scope of our findings concerning the broader continuum of pregnancy-related hypertension.

Conclusion

In the current study, we found that women with hypertensive disorders in pregnancy have a significantly higher risk of complicated pregnancies due to maternal and perinatal adverse effects. A significant risk of cesarean delivery, preterm birth, perinatal death, stillbirth, and low birth weight delivery has been reported in women with hypertensive disorders of pregnancy. To minimize the burden of the problem, health professionals and stakeholders need to do a lot and focus on identifying and properly treating mothers with hypertensive disorders.

Abbreviations

APGAR	Activity Pulse Grimace Appearance Respiration
BMI	Body Mass Index
BP	Blood Pressure
GA	Gestational Age
GDM	Gestational Diabetes Mellitus
HDP	Hypertensive Disorders of Pregnancy
HELLP	Haemolysis, Elevated Liver Enzymes and Low Platelet count
LBW	Low Birth Weight
PE	Preeclampsia
SGA	Small for Gestational Age
WHO	World Health Organization

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Authors' contributions

EZ, FG, MRT, FAK, NA, and SSA wrote the main manuscript. BTR, WTW, BFO, LME, and GGB prepared figures. All authors reviewed the manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the institutional research review ethics committee of Oda Bultum University and Ethical clearance was sought from them. Support letter was obtained from Oda Bultum University to respective Hospitals. Permission was obtained from the administrators of respective Hospitals to conduct the study. Prior data collection, willingness of study participants was confirmed and they was told that withdrawal or decline to participate in the study would not result in any loss to which they are otherwise entitled including denial of any health care service, as this would not result in a penalty, and the purpose, procedure, and benefits of the study. No names or identifying information was indicated on the questionnaires, and all subjects were assured of confidentiality throughout the study. Then, informed written consent was obtained from each study participant. The study adhered to the ethical standards of the Helsinki Declaration for human research ethics.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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