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Perinatal outcomes after hypertensive disorders in pregnancy in a low resource setting

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Abstract

OBJECTIVE The objective of this study was to evaluate perinatal outcomes of pregnancies complicated by hypertensive disorders in pregnancy in an urban sub-Saharan African setting.
METHODS A prospective cohort study of 1010 women of less than 17 weeks of gestation was conducted at two antenatal clinics in Accra, Ghana, between July 2012 and March 2014. Information about hypertensive disorders was available for analysis on 789 pregnancies. The main outcomes were pre-term birth, birthweight, Apgar scores, small for gestational age and mortality. Relative risk (RR, 95% confidence interval (CI)) for the association between hypertensive disorders of pregnancy and perinatal outcomes was assessed using logistic regression adjusting for potential confounders.
RESULTS A total of 88.7% of women remained normotensive, 7.5% developed pregnancy-induced hypertension, 2.0% had chronic hypertension, and 1.7% developed (pre-)eclampsia. No adverse effects were observed in women with pregnancy-induced hypertension. Women with chronic hypertension were more likely to have a lower gestational age at delivery (38.0 ± 2.3 weeks *vs.* 39.0 ± 1.9 weeks, $P = 0.04$) and higher risk of pre-term delivery (aRR 4.63, 95% CI 1.35–15.91). Women with pre-eclampsia had emergency Caesarean section significantly more often (88.9% *vs.* 50%, $P = 0.04$), with a higher risk for low birthweight infants (aRR 7.95, 95% CI 1.41–44.80) and a higher risk of neonatal death (aRR 18.41, 95% CI 1.20–283.22).
CONCLUSION Comparable to high-income countries, in Accra hypertensive disorders during pregnancy were associated with increased risk of adverse perinatal outcomes necessitating maternal and newborn care.

keywords pre-eclampsia, pregnancy-induced hypertension, chronic hypertension, perinatal outcome, pre-term birth, Apgar scores

Introduction

Hypertensive disorders affect about 10% of all pregnancies around the world and are an important cause of maternal and perinatal morbidity and mortality [1–3]. Hypertensive disorders in pregnancy (HDP) include pregnancy-induced hypertension, chronic hypertension, (superimposed) pre-eclampsia and eclampsia with increasing associated morbidity and mortality [4–6]. Nearly a tenth of all maternal deaths in Africa and Asia are associated with pre-eclampsia and eclampsia, and almost a quarter in Latin America. In West Africa, approximately 8% of the causes of maternal deaths are related to hypertensive disorders. Overall, the maternal mortality ratio in Ghana in 2013 was estimated to be 293.4 per 100 000 live births [7, 8].

Pre-eclampsia is associated with disturbed vascular manifestations, oxidative stress and endothelial damage. This affects placental function resulting in poorer perfusion and nutrient supplementation to the foetus [9] and can result in perinatal morbidity and mortality, including intrauterine growth restriction (IUGR), intrauterine foetal

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death (IUGD), prematurity and perinatal mortality [10]. The incidence of small-for-gestational-age (SGA) babies, who are less than the tenth percentile of birthweight for gestation, is estimated at 14–19% of the term births and 12–25% of the pre-term births [10–12]. Hypertensive disorders account for 8–10% [12] of the pre-term births, and more than half of the women with severe pre-eclampsia or eclampsia deliver pre-term [13]. Perinatal mortality rates associated with hypertensive disorders range from 47 to 370 per 1000 births, with the highest mortality rate for severe pre-eclampsia, eclampsia and HELLP syndrome [10]. In low- and middle-income countries (LMICs), pre-eclampsia and eclampsia are the primary obstetric cause of perinatal deaths and account for 25% [14].

Most research has focused on the maternal and neonatal complications due to HDP in high-income countries. Yet, the global burden of disease and mortality due to hypertensive disorders in pregnancy concentrates in LMICs [1, 2, 15]. Therefore, the aim of this study was to analyse perinatal outcomes of women with pregnancies complicated by pregnancy-induced hypertension, chronic hypertension and pre-eclampsia in a prospective cohort in Accra, Ghana, a sub-Saharan African lower middle-income country.

Methods

Study design and population

A prospective cohort was established at two hospitals in Accra, Ghana: Ridge Regional Hospital's Outpatient Clinic and Maamobi General Hospital. Inclusion criteria were fewer than 17 weeks pregnancy and mothers older than 18 years, for ethical reasons. Women with previously established chronic hypertension were excluded, irrespective of parity. The study was conducted between July 2012 and March 2014. Written informed consent was obtained from all participating pregnant women, and ethical approval was granted by the Ghana Health Service Ethical Review Committee.

The study population was categorised in four groups: normotensive pregnancies, pregnancy-induced hypertension (PIH, defined as a *s*ystolic blood pressure level of ≥140 mmHg and/or diastolic blood pressure level of ≥90 mmHg on two separate occasions without proteinuria after 20 weeks of gestation and normotensive pre-pregnancy level) [4], or a composite group of severe hypertensive disorders with eclampsia and pre-eclampsia (defined as a *s*ystolic blood pressure level of ≥140 mmHg and/or diastolic blood pressure level of ≥90 mmHg on two separate occasions with proteinuria (≥300 mg/24 h or ++ on a dipstick) after 20 weeks of gestation. With the occurrence of tonic-clonic seizures in a pregnant or recently delivered woman, women were considered to have eclampsia [2]. Retrospectively, women who had their first elevated blood pressure at <20 weeks of gestation were classified as chronically hypertensive and this comprised the fourth group. In case of only one blood pressure measurement available from admission at the labour ward, women were only considered hypertensive if both systolic blood pressure and diastolic blood pressure were elevated. Gestational ages of onset of hypertension or pre-eclampsia were not available [4–6]. Spontaneous abortions before 24 weeks were excluded from analysis.

Data sources

Participant demographic information and obstetric history was obtained by trained interviewers through structured questionnaires at study inclusion, that is antenatal visit to the participating hospitals. Obstetric and perinatal outcome information was subsequently extracted from the record books at the labour ward and post-natal clinic 4–8 weeks post-partum. Information on women who did not return to the clinic post-partum was obtained through follow-up calls.

Outcome

Perinatal outcome variables included gestational age and mode of delivery, pre-term birth (before 37 weeks and before 34 weeks), birthweight in grams (gr) determined within 24 hour after birth, low birthweight (<2500 gram), Apgar scores after 1 and 5 min after delivery (dichotomised into <7 and ≥7), small for gestational age (birthweight two standard deviations (SD) below the mean for gestational age) and mortality. Missing data were assumed to be missing at random, and analysis of outcome was restricted to women whose information was obtained.

Statistical analysis

Descriptive statistics for dichotomous variables were presented with frequencies and percentage and for continuous variables with means and standard deviations. Student's t-test was used for continuous variables, chi-square test was used for categorical variables, and Fisher's exact test for categorical variable values if there were fewer than five observations.

Relative risk (RR) and the corresponding 95% confidence interval (95% CI) for the association between hypertensive disorders and the main outcomes of interest were estimated by the use of logistic regression. Potential

demographic and obstetric confounders were identified by assessing the relative risk of the association with hypertensive disorders and the main outcomes. Their likelihood ratio was tested to decide whether the variable should be included in the final logistic regression model. Variables were included in the final model if the likelihood ratio was >0.2. Data of the multivariable logistic regression analysis were expressed as adjusted relative risk (aRR) with corresponding 95% CI. Statistical analysis was performed using the statistical software program SPSS Statistics for Windows (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, version 20.0. Armonk, NY, USA: IBM Corp). A two-sided *P*-value of <0.05 was considered statistically significant.

Results

Study population and participants characteristics

Of the 1010 pregnancy women enroled in the study, outcome information was available for 824 (81.6%). Thirty-nine pregnancies ended in a spontaneous abortion, and three resulted in maternal death. HDP information for statistical analysis was available for 789 pregnancies. Table 1 presents baseline characteristics of the pregnant women. A total of 88.7% remained normotensive, 7.5% developed PIH, 2.0% had chronic hypertension, and 1.7% developed pre-eclampsia or eclampsia. Six women had a twin pregnancy (0.73%), two of whom were in the pre-eclamptic group (Figure 1).

Women with pre-eclampsia and chronic hypertension were significantly older than normotensive women (normotensive 28.0 ± 4.9 years; pre-eclampsia 30.8 ± 5.6 years, $P = 0.03$; chronic hypertension 33.0 ± 5.2 years, $P = 0.00$). Other baseline characteristics did not differ between the groups (Table 1).

Obstetric and perinatal outcomes

As shown in Table 2 for 795 infants, normotensive women delivered 88.6%, women with PIH delivered 7.4%, and women with chronic hypertension delivered 2.0%, as did women with pre-eclampsia or eclampsia.

No adverse effects were observed in women with PIH. Women with chronic hypertension had a significantly lower mean gestational age at delivery (38.0 ± 2.3 weeks *vs.* 39.0 ± 1.9 weeks, $P = 0.04$), and a higher percentage of pre-term births before 37 weeks (26.7% *vs.* 7.2%, $P = 0.02$). The Apgar score after 1 min was significantly lower in infants from chronically hypertensive women (35.7% *vs.* 14.0%, $P = 0.04$) and normalised by 5 min. No other differences in outcomes were observed.

Women with pre-eclampsia or eclampsia had an emergency Caesarean section significantly more often than normotensive women (88.9% *vs.* 50%, $P = 0.04$), with lower birthweight infants (2550 ± 720 gr *vs.* 3125 ± 483 gr, $P = 0.01$), weight <2500 gr (46.2% *vs.* 6.8%, $P = 0.00$) and low Apgar score after 1 and 5 min (1 min: 31.2% *vs.* 14.0%, $P = 0.05$; 5 min: 18.8% *vs.* 3.7%, $P = 0.02$). A trend towards a lower gestational age at delivery (37.8 weeks ± 2.4 *vs.* 39.0 ± 1.9, $P = 0.06$) was observed.

Association between HDP and perinatal outcomes

Women with chronic hypertension were at significantly higher risk to deliver a premature child born before 37 weeks (aRR 4.63, 95% CI 1.35–15.91), an infant with a low Apgar score after 1 min (RR 3.42, 95% CI 1.12–10.42), which disappeared when adjusted for confounders (aRR 2.61, 95% CI 0.80–8.46). Pre-eclamptic or eclamptic women had a higher risk of a low birthweight infant (aRR 7.95, 95% CI 1.41–44.80) and a higher risk of neonatal death (aRR 18.41, 95% CI 1.20–283.22). Pre-eclamptic or eclamptic women also had persistent low Apgar scores after 5 min (RR 5.95, 95% CI 1.60–22.23) and a higher risk of pre-term birth (RR 6.17, 95% CI 1.50–25.41), which disappeared when adjusted for confounders, respectively (aRR 3.34, 95% CI 0.59–19.05) and (aRR 5.50, 95% CI 0.81–37.24) (Table 3).

Discussion

Our results indicate that women with chronic hypertension and pre-eclampsia have a higher risk of adverse perinatal outcomes in an urban low-resource setting. Women with chronic hypertension have an increased risk for a pre-term birth and a child with a lower Apgar score after 1 min. Women with pre-eclampsia are at increased risk to deliver by an (emergency) Caesarean section and have a higher risk of neonatal death.

Most previous studies on the perinatal outcomes of hypertensive disorder during pregnancies were conducted in high-income countries, although the incidence and complications of these disorders are higher in LMICs [1, 2, 15]. Hence, this study contributes to the small body of literature on LMICs. Studies in the United Kingdom [16], Germany [17], Italy [18] and Saudi Arabia [19] show that pre-eclampsia is associated with pre-term delivery, lower birthweight and lower Apgar scores [16–19]. PIH is associated with pre-term delivery and lower birthweight [16, 18] and chronic hypertension is associated with pre-term delivery and lower birthweight [18]. Our study shows corresponding results in previous reported

Table 1 Socio-demographic and socio-economic information of 789 pregnant women in Accra, Ghana

	Socio-demographic and socio-economic information						
	NT *n* (%)	PIH *n* (%)	NT *vs.* PIH	PE *n* (%)	NT *vs.* PE	CHT *n* (%)	NT *vs.* CHT
Pregnancies	700 (88.7)	59 (7.5)		14 (1.7)		16 (2.0)	
	Mean ± SD	Mean ± SD	*P*-value	Mean ± SD	*P*-value	Mean ± SD	*P*-value
Maternal age (years)	28.0 ± 4.9	28.5 ± 5.4	0.46	30.8 ± 5.6	**0.03**	33.0 ± 5.2	**0.00**
	n (%)	*n* (%)	*P*-value	*n* (%)	*P*-value	*n* (%)	*P*-value
Area of residence							
Accra Metropolitan Area	534 (77.6)	49 (83.1)	0.71	12 (85.7)	0.33	14 (87.5)	0.86
Other urban area	133 (19.0)	9 (15.3)		1 (7.1)		2 (12.5)	
Peri-urban and rural area	24 (3.4)	1 (1.7)		1 (7.1)		0 (0)	
Level of education							
No formal education	73 (10.4)	7 (11.9)	0.96	1 (7.1)	0.07	1 (6.2)	0.37
Primary school	83 (11.9)	5 (8.5)		0 (0.0)		4 (25.0)	
Lower secondary school	331 (47.3)	29 (49.2)		4 (28.6)		9 (56.2)	
Upper secondary school	197 (28.1)	17 (28.8)		8 (57.1)		2 (12.5)	
Higher tertiary education	16 (2.3)	1 (1.7)		1 (7.1)		0 (0)	
Economic activity							
Informal sector employment	530 (75.7)	39 (66.1)	0.15*	10 (71.4)	0.64	14 (87.5)	0.75
Formally employed	87 (12.4)	8 (13.6)		3 (21.4)		1 (6.2)	
Not economically active	83 (11.9)	12 (20.3)		1 (7.1)		1 (6.2)	
Marital status							
Single, widowed	126 (18.0)	10 (16.9)	0.59*	2 (14.3)	0.37	2 (12.5)	0.27
Married	432 (61.7)	40 (67.8)		7 (50.0)		13 (81.2)	
Engaged/Living together	142 (20.3)	9 (15.3)		5 (35.7)		1 (6.2)	

NT, normotensive women; PE, women with pre-eclampsia; CHT, women with chronic hypertension; *n*, number; SD, standard deviation; yrs, years.
Statistically significant *P*-values are shown in bold.
**P*-value calculated by using chi quare, all other *P*-values calculated by Fisher's exact.

incidence of SGA babies and pre-term births in women with pre-eclampsia [10–12].

One of the few studies in LMIC setting was by Olusanya *et al.* [20] in a referral hospital in Nigeria who retrospectively compared the neonates born to 216 mothers with chronic hypertension (4.6%), PIH (55.6%), pre-eclampsia or eclampsia (39.8%) and compared them to 3275 normotensive pregnancy women. In their analyses, all HDP were aggregated, reducing the study's ability to discriminate outcomes by disorder. However, they observed similar patterns in perinatal outcomes.

Ridge Regional Hospital has been investing in an improved care program in the past years [21–23]. This may have been reflected by the gestational age at delivery. The Ghana Safe Motherhood Protocol [24] recommends delivery after 38 weeks of gestation for women with PIH and delivery after 37 weeks for mild pre-eclampsia. For PIH, both the mean gestational age and perinatal outcomes were similar to that of normotensive women. For pre-eclampsia, the mean gestational age was 37.8 weeks [1, 7, 25].

However, although overall performance in pregnancy outcomes was observed to be reasonably good, the perinatal outcomes indicate room for improvement and suggest that the optimal care delivered in a low-resource setting should continue to be an important focus for future clinical studies [26]. For a comprehensive strategy to improve perinatal outcomes, other factors associated with adverse outcomes could be considered as well including social determinants resulting in inequities [27].

One of the strengths of this study is the prospective character and inclusion of healthy pregnant women in early pregnancy, contrary to most of the retrospectively conducted perinatal outcomes research [10, 16, 18–20]. Neonatal outcomes in the current study were obtained from the record books and verified in interviews.

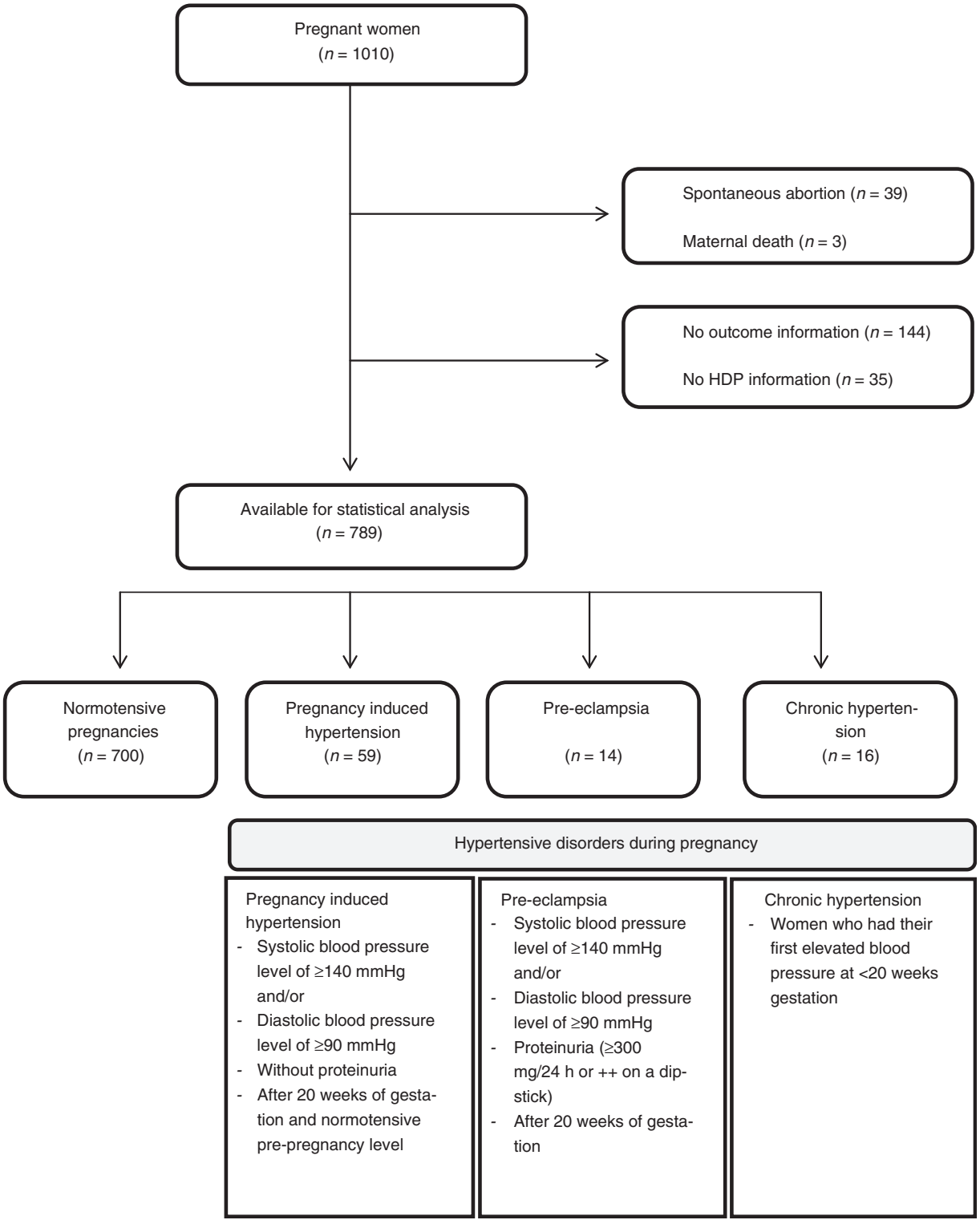

Figure 1 Consort chart.

Table 2 Obstetric information and perinatal outcomes of 789 pregnant women in Accra, Ghana

	Obstetric information						
	NT *n* (%)	PIH *n* (%)	NT *vs.* PIH	PE *n* (%)	NT *vs.* PE	CHT *n* (%)	NT *vs.* CHT
Pregnancies	700 (88.7)	59 (7.5)		14 (1.7)		16 (2.0)	
Children	704 (88.6)	59 (7.4)		16 (2.0)		16 (2.0)	
	Mean ± SD	Mean ± SD	*P*-value	Mean ± SD	*P*-value	Mean ± SD	*P*-value
Gestational age (wks)	39.0 ± 1.9	39.1 ± 2.3	0.86	37.8 ± 2.4	0.06	38.0 ± 2.3	**0.04**
Pre-term birth <37 wks	34.6 ± 2.6	32.0 ± 4.4	0.12	35.0 ± 1.4	0.84	35.3 ± 1.0	0.63
Pre-term birth <34 wks	31.2 ± 3.2	30.5 ± 4.9	0.78	34.0 ± n.a.	0.42	34.0 ± n.a.	0.42
	n (%)	*n* (%)	*P*-value	*n* (%)	*P*-value	*n* (%)	*P*-value
Pre-term birth <37 wks	48 (7.2)	3 (5.7)	1.00	2 (25.0)	0.11	4 (26.7)	**0.02**
Pre-term birth <34 wks	13 (2.0)	2 (3.8)	0.31	1 (12.5)	0.16	1 (6.7)	0.27
Primipara	146 (20.9)	17 (28.8)	0.15*	0 (0)	0.09	3 (18.8)	1.00
Delivery mode							
Vaginal delivery	628 (89.7)	52 (88.1)	0.66	5 (35.7)	**0.00**	14 (93.8)	1.00
Caesarean section	72 (10.3)	7 (11.9)		9 (64.3)		1 (6.2)	
Emergency CS	36 (50)	4 (57.1)	1.00	8 (88.9)	**0.04**	0 (0)	1.00
	Perinatal outcomes						
	NT Mean ± SD	PIH Mean ± SD	NT *vs.* PIH *P*-value	PE Mean ± SD	NT *vs.* PE *P*-value	CHT Mean ± SD	NT *vs.* CHT *P*-value
Birthweight (gram)	3125 ± 483	3255 ± 483	0.05	2550 ± 720	**0.01**	2914 ± 537	0.09
	n (%)	*n* (%)	*P*-value	*n* (%)	*P*-value	*n* (%)	*P*-value
SGA	15 (2.3)	1 (1.9)	1.00	1 (14.3)	0.16	1 (6.7)	0.31
Apgar score after 1 min							
Low (<7)	94 (14.0)	13 (22.0)	0.09*	5 (31.2)	**0.05***	5 (35.7)	**0.04**
Apgar score after 5 min							
Low (<7)	25 (3.7)	2 (3.4)	1.00	3 (18.8)	**0.02**	1 (7.1)	0.51*
Still birth	9 (1.3)	1 (1.7)	0.55	1 (6.2)	0.20	1 (6.2)	0.20
Birth weight <2500 gram	47 (6.8)	1 (1.7)	0.16	6 (46.2)	**0.00**	1 (6.7)	1.00

NT, normotensive women; PE, women with pre-eclampsia; CHT, women with chronic hypertension; *n*, number; SD, standard deviation; wks, weeks.
Statistically significant *P*-values are shown in bold.
**P*-value calculated using chi-square, all other *P*-values calculated by Fisher's exact test. n.a. , not able to calculate results, wks, weeks.

Extensive efforts were made to complete the study, reflected by the relatively high follow-up (>80%), despite the difficulties in tracking women and the preference of some women to deliver at another hospital or with family. Women who were lost to follow-up were slightly younger, more likely to be nulliparous and had a lower BMI at booking (data not shown). They were also more likely to have a lower socio-economic status (less education, more often among the poorest 40% of the population, more often single or engaged, or born in rural areas); therefore, a possible reason for the loss-to-follow-up could be that these women may have travelled to their home towns for assistance during and after delivery (data not shown). Selective loss-to-follow-up of women with an uncomplicated pregnancy who are more likely to deliver at home may have led to an overestimation of the reported perinatal risk. However, considering that home deliveries are associated with a high risk of perinatal complications, even among low-risk women [28], underestimation of reported perinatal risk also has to be considered.

Table 3 Logistic regression on the association between hypertensive disorders in pregnancy and obstetric and perinatal outcomes of 789 pregnant women in Accra, Ghana

Outcomes	NT *vs.* PIH RR (95% CI)	*P*-value	NT *vs.* PIH aRR (95% CI)	*P*-value
Pre-term birth (<37 weeks)	0.74 (0.22–2.46)	0.62	0.79 (0.23–2.64)*	0.70
Small for gestational age (<2 SD)	0.82 (0.11–6.34)	0.85	0.78 (0.10–6.07)†	0.81
Apgar score 1 min (<7)	1.74 (0.90–3.34)	0.10	1.8 (0.92–3.65)‡	0.09
Apgar score 5 min (<7)	0.90 (0.21–3.92)	0.89	0.70 (0.13–3.70)†	0.67
Birthweight (<2500 g)	0.24 (0.03–1.74)	0.16	0.20 (0.02–1.85)‡	0.16
Neonatal death	1.33 (0.17–10.69)	0.79	1.13 (0.10–12.89)§	0.92
Outcomes	**NT *vs.* PE RR (95% CI)**	***P*-value**	**NT *vs.* PE aRR (95% CI)**	***P*-value**
Pre-term birth (<37 weeks)	6.17 (1.50–25.41)	**0.01**	3.34 (0.59–19.05)¶	0.17
Small for gestational age (<2 SD)	7.11 (0.71–62.78)	0.08	5.05 (0.49–51.77)**	0.17
Apgar score 1 min (<7)	2.80 (0.95–8.23)	0.06	2.98 (0.65–13.61)††	0.16
Apgar score 5 min (<7)	5.95 (1.60–22.23)	**0.01**	5.50 (0.81–37.24)†	0.08
Birthweight (<2500 g)	10.29 (3.43–30.89)	**0.00**	7.95 (1.41–44.80)‡	**0.02**
Neonatal death	5.15 (0.61–43.25)	0.13	18.41 (1.20–283.22)††	**0.04**
Outcomes	**NT vs CHT RR (95% CI)**	***P*-value**	**NT vs CHT aRR (95% CI)**	***P*-value**
Pre-term birth (<37 weeks)	4.49 (1.38–14.61)	**0.01**	4.63 (1.35–15.91)*	**0.02**
Small for gestational age (<2 SD)	3.05 (0.38–24.70)	0.30	3.26 (0.36–29.87)‡	0.30
Apgar score 1 min (<7)	3.42 (1.12–10.42)	**0.03**	2.61 (0.80–8.46)††	0.11
Apgar score 5 min (<7)	1.99 (0.25–15.77)	0.51	1.11 (0.12–10.28)††	0.93
Birthweight (<2500 g)	0.98 (0.13–7.61)	0.99	0.90 (0.11–7.72)‡	0.93
Neonatal death	5.15 (0.61–43.25)	0.13	8.58 (0.76–96.50)††	0.08

NT, normotensive women; PIH, women with pregnancy-induced hypertension; PE, women with pre-eclampsia; CHT, women with chronic hypertension; RR, unadjusted relative ratio; aRR, adjusted relative risk; 95% CI, 95% confidence interval.
Statistically significant *P*-values are shown in bold.
*Adjusted for maternal age, parity, type of delivery, education and employment.
†Adjusted for gestational age, parity, type of delivery, education and employment.
‡Adjusted for gestational age, maternal age, parity, type of delivery, and education.
§Adjusted for gestational age, maternal age, type of delivery, and education.
¶Adjusted for parity, type of delivery, education and employment.
**Adjusted for gestational age, parity, type of delivery and education.
††Adjusted for gestational age, maternal age, parity, type of delivery, education and employment.

Limitations reflect the relatively small group of women with pre-eclampsia (n = 14), which limit our ability to draw firm conclusions on the magnitude of adverse events. Yet, the consistent direction of results of the parameters investigated suggests a higher risk for adverse perinatal outcomes in women with HDP.

Maternal body mass index (BMI) is a strong risk factor for HDP during pregnancy, leading to complications during pregnancy, delivery and post-partum for both mother and offspring [29, 30]. We previously reported in this cohort the association between a higher BMI status and increased risk of Caesarean sections, PIH, chronic hypertension and macrosomia without an elevated risk of miscarriage, stillbirth, neonatal death, low Apgar scores at 1 and 5 min or low birthweight. The maternal BMI was based on weight during early pregnancy, as a proxy for pre-pregnancy weight, which could possibly have influenced the reported results [31].

Conclusion

Comparable to high-income countries, in an urban resource-limited setting, hypertensive disorders during pregnancy were associated with a higher risk of adverse perinatal outcomes. Women with hypertensive disorders during pregnancy had a higher risk of (emergency) Caesarean section, pre-term birth, neonatal death, low birthweight children and neonates with low Apgar score. We

observed high-quality care in an economically poor setting that may in part be attributed to a successful quality improvement program, indicating the value of a continued focus on optimising quality of care.

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