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Regional differences in clinical characteristics and fetal and maternal outcomes of hypertensive disorders in pregnancy in China: a retrospective study

Ma Rui^a, Huang Liping^{b,*}, Wang Yanmin^{c,d}, Zhao Tingting^a, Chen Shi^c, and He Yingdong^c

^aDepartment of Obstetrics and Gynecology, Peking University First Hospital Ningxia Women and Children's Hospital (Ningxia Hui Autonomous Region Maternal and Child Health Hospital), Yinchuan, PR. China; ^bDepartment of Obstetrics and Gynecology, Fujian Maternity and Child Health Hospital, College of Clinical Medicine for Obstetrics & Gynecology and Pediatrics, Fujian Medical University, Fuzhou, PR. China; ^cDepartment of Obstetrics and Gynecology, Peking University First Hospital, Beijing, PR. China; ^dDepartment of Obstetrics and Gynecology, Luanzhou People's Hospital, Luanzhou, PR. China

ABSTRACT

Background: Hypertensive disorders in pregnancy (HDPs) are the leading causes of maternal and perinatal death worldwide, and appropriate prenatal care is beneficial toward improve pregnancy outcomes in populations at high risk of preeclampsia.

Objective: To describe variations in regional manifestations and outcomes of HDPs among the Chinese population to aid in the development of region-specific perinatal management guidelines.

Methods: This is a retrospective study. The clinical data of patients with HDP in 3 different regions were collected to explore the characteristics of HDP patients in different regions of China.

Results: In Peking University First Hospital, a regional rescue center for prenatal care and delivery, the proportion of patients with high-risk factors for PE was considerably high; 37.8% were of advanced maternal age, and 14.7% were obese. Among the patients, at this hospital, the proportion of comorbidities (e.g., chronic hypertension) in HDP patients was higher than that in the other 2 specialized maternal and child health care hospitals.

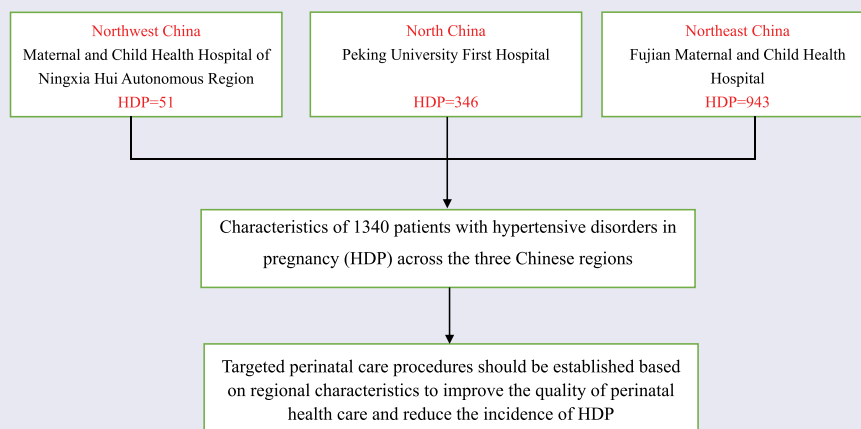
Conclusion: Targeted prenatal care procedures should be established based on regional characteristics to improve the quality of perinatal health care and reduce the incidence of HDP.

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Hypertensive disorders in pregnancy; preeclampsia; perinatal care



Introduction

Hypertensive disorders in pregnancy (HDP) are the leading cause of maternal and perinatal death worldwide (1,2) and are classified mainly into four categories: gestational hypertension (GH), preeclampsia-eclampsia, chronic hypertension and chronic hypertension with superimposed

preeclampsia. The clinical management of preeclampsia (PE) has always been a popular topic in obstetrics research. Although some consensus pregnancy management guidelines have been established for patients with high-risk factors for PE (3–6), further studies are needed to determine the necessity for establishing region-specific and

CONTACT He Yingdong  dongyinghe1234@163.com  Department of Obstetrics and Gynecology, Peking University First Hospital, Beijing 100034, PR. China

*Huang Liping is the co-first author.

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population-specific antenatal care models for high-risk PE patients based on consensus management.

Clinicians have become increasingly aware of the severe consequences of PE, actively providing corresponding treatments. However, clinicians often ignore the role of high-quality prenatal care in reducing the incidence of PE, delaying early-onset severe preeclampsia (SPE), monitoring the progression of GH toward preeclampsia (7–9) and reducing the risk of serious complications of PE [9]. In actual clinical practice, some obstetricians still believe that PE is unpredictable and unpreventable, and they still consider “timely” termination of pregnancy as the primary treatment for PE, failing to fully recognize the important role of proper prenatal care procedures and a targeted and individualized health care system in improving the prognosis of patients with PE. Therefore, prenatal care for patients at high risk for PE is somewhat standardized, generalized, and stereotyped. It is believed that calcium supplementation for calcium-deficient individuals and low-dose aspirin for individuals at risk for PE can effectively prevent PE (3–6,10). Currently, the guidelines for pregnancy health care formulated by various countries and academic organizations recommend that different health care procedures be provided on the basis of the risk level of pregnant women and that prenatal care for high-risk pregnant women be provided by experts in maternal-fetal medicine to ensure proper pregnancy monitoring and patient care (11–13). As such, patients with high-risk factors for PE often receive PE-relevant attention during the perinatal period. However, the rate of PE in women with a “normal” pregnancy without high-risk factors is 50% (4,6). Therefore, it is important to provide high-quality prenatal care to reduce the adverse effects of PE on mothers and infants (13,14). In addition, differences in the economic development level and ethnicity composition in different regions have direct impacts on the risk of PE, and prenatal care institutions of different levels in the same region serve vastly different pregnancy populations. Hence, an investigation of the population characteristics and clinical characteristics of PE patients in different regions and in prenatal care institutions of different levels is of great clinical significance to formulate more targeted prenatal care procedures.

Materials and methods

Selection of study participants

In this study, the clinical data of patients with HDP who received prenatal care and delivered at Peking University First Hospital, Fujian Maternal and Child Health Hospital, and the Maternal and Child Health

Hospital of Ningxia Hui Autonomous Region from January 1 to 31 December 2018, were retrospectively retrieved. The following data were collected: demographic characteristics, high-risk factors for PE, clinical characteristics of HDP, and maternal and fetal pregnancy outcomes. These three hospitals are in North China, Southwest China and Northwest China. Regarding the levels of the hospitals, Peking University First Hospital is a tertiary maternal and child health care institution and a regional emergency center for critically ill pregnant women; Fujian Maternal and Child Health Hospital is a specialized hospital for obstetrics and pediatrics and a tertiary maternal and child health care institution with a regional emergency center for critically ill pregnant women; and the Maternal and Child Health Hospital of Ningxia Hui Autonomous Region is a secondary maternal and child health care institution.

The study was undertaken in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Peking University First Hospital. The data are anonymous, and the requirement for informed consent was therefore waived.

Study methods

Medical data from patients with GH during pregnancy were retrieved, and clinical data from study subjects were retrospectively analyzed.

- (1) The following basic clinical data of the patients with HDP were collected: age, ethnicity, parity, height, weight, singleton/twin pregnancy, and pregnancy complications such as chronic hypertension (CH), diabetes mellitus, thyroid disease, autoimmune disease, and chronic kidney disease.
- (2) Maternal pregnancy outcomes included specific types of HDP (GH, CH, PE/eclampsia, and concurrent PE and CH), gestational age at onset of HDP, gestational age at delivery, mode of delivery, anemia, gestational diabetes mellitus (GDM), placental abruption, incidence rate of postpartum hemorrhage, and hepatic and renal impairment.
- (3) Fetal outcomes included gestational age at delivery, birth weight, perinatal mortality, fetal growth restriction (FGR), late preterm birth, moderate and very preterm birth, low birth weight (LBW), and very low birth weight (VLBW).
- (4) Severe adverse maternal outcomes included eclampsia, placental abruption, pulmonary edema, heart failure, disseminated intravascular

coagulation (DIC), acute renal failure (ARF), neonatal intensive care unit (NICU) admission, and maternal death.

Operational definitions

Chronic hypertension was defined as hypertension that was present at the booking visit or before 20 weeks' gestation or if the woman was already taking antihypertensive medication when starting maternity care. It could be primary or secondary in etiology.

GH was defined as new hypertension presenting after 20 weeks of pregnancy without significant proteinuria.

Preeclampsia was defined as gestational hypertension with new-onset proteinuria or one/more maternal end-organ complications. Severe preeclampsia was diagnosed when preeclampsia was concomitant with any of the following findings: (1) blood pressure ≥ 160 mmHg systolic or ≥ 110 mmHg diastolic occurring after 20 weeks of gestation in a previously normotensive woman; (2) thrombocytopenia; (3) impaired liver function, as indicated by an abnormally elevated blood concentration of liver enzymes, severe persistent right upper quadrant or epigastric pain unresponsive to medication and not accounted for by alternative diagnoses, or both; (4) progressive renal insufficiency; (5) pulmonary edema; (6) new-onset cerebral or visual disturbances; (7) heart failure; (8) placental abruption and (9) FGR.

Chronic hypertension with superimposed preeclampsia: chronic hypertension with any characteristics of preeclampsia.

The criteria for the diagnosis of HELLP syndrome require the presence of the following laboratory findings: (1) hemolysis, defined by abnormal peripheral smear, increased bilirubin (≥ 20.5 $\mu\text{mol/L}$), and increased lactic dehydrogenase ($\text{LDH} \geq 600$ U/L); (2) elevated liver enzymes, defined as increased serum aspartate aminotransferase levels ($\text{AST} \geq 70$ U/L) and increased LDH; and (3) low platelets, defined as $\text{PLT} < 100 \times 10^9/\text{L}$.

The diagnostic criteria for anemia (15), GDM (16), and postpartum hemorrhage (17) were obtained from the corresponding guidelines. Preterm birth was defined as delivery before 37 weeks' gestational age. Early preterm birth was defined as delivery before 34 weeks' gestational age.

Other parameters were defined as follows: Advanced maternal age (age > 35 years), obesity (body mass index (BMI) ≥ 30 kg/m^2), low BMI ($\text{BMI} < 18$ kg/m^2), and anemia (hemoglobin (Hb) < 100 g/L). Renal damage was defined as serum creatinine (Scr) ≥ 102 $\mu\text{mol/L}$. Hypoproteinemia was

defined as albumin (ALB) < 25 g/L. Hepatic impairment was defined as alanine aminotransferase (ALT) ≥ 40 U/L and/or aspartate aminotransferase (AST) ≥ 35 U/L. Late preterm birth was defined as delivery at a gestational age ≥ 34 weeks but < 37 weeks. Very preterm birth was defined as gestational age ≥ 28 weeks but < 34 weeks. LBW birth was defined as weight < 2500 g. VLBW was defined as birth weight < 1500 g.

Statistical analysis

Continuous variables are presented as the mean \pm standard deviation (SD) or the median and range. Depending on the data distribution, data were compared using *t* tests or nonparametric tests. The relationships among advanced maternal age, obesity, chronic hypertension and PE/SPE were assessed using logistic regression analysis. Categorical variables are presented as frequencies and percentages and were compared using the χ^2 test or Fisher's exact test. A two-sided *P* value < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS (version 23.0, IBM, NY, USA).

Results

Baseline characteristics

In 2018, a total of 6,170 women delivered at Peking University First Hospital, among whom 346 had HDP (Group A); 17332 women delivered at Fujian Maternal and Child Health Hospital, among whom 943 patients had HDP (Group B); and 2757 women delivered at the Maternal and Child Health Hospital of Ningxia Hui Autonomous Region, among whom 51 patients had HDP (Group C). The details on the baseline characteristics of the HDP patients are shown in Table 1.

Maternal pregnancy outcomes

Regarding types of HDP, the proportion of GH cases was significantly higher in group B (38.6%) than in group A (21.4%) or group C (29.4%) ($P < 0.01$); the proportion of mild PE cases was significantly higher in group B (22.4%) and group C (29.4%) than in group A (5.7%) ($P < 0.01$); and the proportions of CH cases (27.2%) and hemolysis elevated liver enzymes and low platelet (HELLP) syndrome (7.5%) cases were significantly higher in group A than in group B (CH: 0.4%, HELLP: 2.3%) or group C (CH: 0.2%) ($P < 0.01$). Regarding gestational age at HDP onset, the proportion of patients with onset before 34 weeks was the highest in group A (56.9%) and the lowest in group B (11.8%) ($P < 0.01$). For gestational age at delivery, the

Table 1. Baseline characteristics of 1,340 pregnancy complicated by hypertensive disorders across the three Chinese regions.

	A	B	C	αp	βp	γp
No. of deliveries	6170	17332	2757			
Age ($\bar{x} \pm SD$) (years)	33.02 \pm 4.344	31.30 \pm 5.100	29.18 \pm 5.283	<0.01	<0.01	<0.01
≤24	6 (1.7%)	82 (8.7%)	9 (17.7%)	<0.01	<0.01	0.06
25–29	69 (19.9%)	347 (36.8%)	20 (39.2%)	<0.01	<0.01	0.84
30–34	140 (40.5%)	283 (30.0%)	16 (31.4%)	<0.01	0.28	0.96
35–39	110 (31.8%)	179 (19.0%)	3 (5.9%)	<0.01	<0.01	0.03
≥40	21 (6.0%)	52 (5.5%)	3 (5.9%)	0.81	0.79	0.84
Ethnicity						
Han	331 (95.7%)	899 (95.3%)	35 (68.63%)	0.92	<0.01	<0.01
Other races	15 (4.3%)	44 (4.7%)	16 (31.37%)	0.92	<0.01	<0.01
Parity						
0	155 (44.7%)	537 (56.9%)	37 (72.5%)	<0.01	<0.01	0.04
1	125 (36.1%)	362 (38.3%)	12 (23.5%)	0.46	0.11	0.047
≥2	66 (19.1%)	44 (4.7%)	2 (3.9%)	<0.01	0.01	0.61
BMI (kg/m^2)						
<18.5	8 (2.3%)	122 (12.9%)	5 (9.8%)	<0.01	0.017	0.66
18.5–23.9	155 (44.8%)	566 (60.0%)	22 (43.1%)	<0.01	0.94	0.02
24–27.9	92 (26.6%)	186 (19.7%)	18 (35.3%)	<0.01	0.26	0.012
28–29.9	40 (11.6%)	36 (3.8%)	5 (9.8%)	<0.01	0.71	0.08
≥30	51 (14.7%)	33 (3.5%)	1 (2.0%)	<0.01	0.01	0.85
Comorbidities						
Chronic hypertension	115 (33.2%)	41 (4.3%)	5 (9.8%)	<0.01	<0.01	.14
Diabetes mellitus	25 (5.92%)	19 (2.01%)	0 (0)	<0.01	.09	.62
Thyroid disease	35 (9.0%)	101 (10.7%)	4 (7.8%)	0.76	0.78	0.68
Autoimmune disease	10 (2.9%)	0	0	-	-	-
Chronic kidney disease	13 (3.5%)	14 (1.5%)	0	<0.01	-	-

Abbreviations: SD, standard deviation BMI: body mass index; α : A v.s. B; A v.s. C; B v.s. C.

proportion of full-term births was the lowest in group A (63.9%, $P < 0.02$). The risk of severe adverse maternal pregnancy outcomes was significantly higher for patients in Group A than for patients in group B or group C. There were no maternal deaths in any of the hospitals. The maternal pregnancy outcomes are shown in Table 2.

Among these 1340 patients with HDP, in the multi-variate logistic regression analysis, maternal age ≥ 35 years [odds ratio (OR) = 2.46, 95% confidence interval (CI): 1.27–4.75, $P < 0.01$] and obesity (OR = 4.101, 95% CI: 1.834–9.167, $P < 0.01$) were risk factors for preeclampsia, and chronic hypertension (OR = 5.051, 95% CI: 2.744–9.3, $P < 0.01$) was a risk factor for SPE.

Fetal/Neonatal outcomes

There were 45 twin pregnancies in group A, 104 in group B, and 4 in group C. The overall fetal survival rates in groups A, B and C were 95.7%, 98.9%, and 100%, respectively. The fetal survival rate was significantly lower in group A than in group B or group C. A total of 88% (15/17) of fetal/neonatal deaths in group A occurred in fetuses/neonates delivered before 28 weeks of gestation, and 66.7% (8/12) in group B occurred in neonates born at 28–33⁺⁶ weeks of gestation. The incidence rate of FGR (15.2%) was significantly higher in group A than in group B (9.4%) or group C (9.1%) ($P < 0.01$). The mean birth weights of neonates in groups A, B, and C were 2699.62 \pm 797.213

g, 2896.42 \pm 717.353 g and 3094.64 \pm 548.784 g, respectively. The incidence rates of VLBW and LBW were significantly higher in group A than in group B or group C ($P < 0.01$). The Fetal/Neonatal outcomes are shown in Table 3.

Discussion

This study selected patients with HDP in 3 different hospitals in China as the research objects and explored the characteristics of HDP patients in different regions and in hospitals of different levels, finding that the demographic characteristics, composition of high-risk factors, and maternal/infant outcomes of HDP patients varied greatly among the 3 hospitals. It is important to establish prenatal care procedures based on regional and hospital features to improve the overall prognosis of patients with HDP.

Through this study, we found that among the HDP patients admitted to Peking University First Hospital, a regional rescue center for prenatal care and delivery, the proportion of patients with high-risk factors for PE, such as advanced maternal age and obesity, was considerably high. Hence, nutritional management and weight monitoring should be the focus of perinatal health care in such hospitals so that HDP patients can not only obtain sufficient energy intake to meet the needs of fetal growth but also control weight gain within a reasonable range to avoid increasing the risk of HDP. In contrast, 12.9% of the HDP patients in

Table 2. Maternal outcome of 1,340 pregnancy complicated by hypertensive disorders across the three Chinese regions.

	A	B	C	αp	βp	γp
No. of HDP	346/6170 (5.61%)	943/17332 (5.44%)	51/2757 (1.85%)	0.62	<0.01	<0.01
GH	74 (21.4%)	364 (38.6%)	15 (29.4%)	<0.01	<0.01	<0.01
CH	94 (27.2%)	4 (0.4%)	1 (0.2%)	<0.01	<0.01	0.62
CH+PE	21 (6.1%)	37 (3.9%)	4 (7.8%)	0.14	0.86	0.31
PE	20 (5.7%)	211 (22.4%)	15 (29.4%)	<0.01	<0.01	0.32
SPE	110 (41.0%)	305 (32.3%)	16 (39.2%)	0.85	0.92	0.99
HELLP syndrome	26 (7.5%)	22 (2.3%)	0	<0.01	-	-
Eclampsia	1 (0.3%)	0	0	-	-	-
Gestational weeks when HDP onset (weeks)						
<34	197 (56.9%)	111 (11.8%)	14 (27.5%)	<0.01	<0.01	<0.01
≥34	149 (43.1%)	832 (88.2%)	37 (72.5%)	<0.01	<0.01	<0.01
Singleton pregnancy	301 (87.0%)	839 (89.0%)	47 (92.2%)	0.33	0.30	0.48
Twin pregnancy	45 (13.0%)	104 (11.0%)	4 (7.8%)	0.33	0.30	0.48
Gestational weeks at delivery (weeks)						
<28	22 (6.3%)	3 (0.3%)	0	<0.01	-	-
28–33	44 (12.7%)	92 (9.8%)	0	0.13	-	-
34–36	59 (17.1%)	157 (16.7%)	6 (11.8%)	0.86	0.34	0.36
≥37	221 (63.9%)	691 (73.3%)	45 (88.2%)	<0.01	<0.01	0.02
Complications						
Anemia	56 (16.2%)	218 (23.1%)	12 (23.5%)	<0.01	0.27	0.92
GDM	114 (32.9%)	258 (27.4%)	5 (9.8%)	.06	<0.01	<0.01
Postpartum hemorrhage	105 (30.3%)	160 (17.0%)	4 (7.8%)	<0.01	<0.01	0.13
Scr≥102 μmol/L	13 (3.8%)	8 (0.8%)	0	<0.01	-	-
ALB<25 g/L	10 (2.9%)	49 (5.2%)	0 (0.0%)	0.11	0.45	0.18
ALT≥40 U/L	22 (6.4%)	52 (5.5%)	1 (2.0%)	0.66	0.35	0.44
AST≥35 U/L	34 (9.8%)	75 (8.0%)	3 (5.9%)	0.34	0.52	0.79
Severe adverse maternal outcomes						
Placental abruption	3 (0.9%)	31(3.3%)	2 (3.9%)	0.03	0.25	0.88
Heart failure	10 (2.9%)	8 (0.8%)	0	.01	-	-
Pulmonary edema	2 (0.6%)	4 (0.4%)	0	.92	-	-
ICU admission	4 (1.2%)	7 (0.7%)	0	.71	-	-
Acute kidney injury	13 (3.8%)	8 (0.8%)	0	<.01	-	-
Mode of delivery (based on number of live births, %)						
No. of live birth	329	931	51			
Vaginal delivery	97 (29.5%)	343 (36.8%)	23 (45.1%)	0.01	0.03	0.24
Caesarean section	232 (70.5%)	588 (63.2%)	28 (54.9%)	0.01	0.03	0.24

Abbreviations: HDP: hypertension disorders in pregnancy, GH: gestational hypertension, CH: chronic hypertension, PE: preeclampsia, SPE: severe preeclampsia, HELLP: hemolysis elevated liver enzymes and low platelet, GDM: gestational diabetes mellitus, Scr: Serum creatinine, ALB: albumin, ALT: alanine aminotransferase, AST: aspartate aminotransferase; α : A v.s. B; β : A v.s. C; γ : B v.s. C.

Fujian Maternal and Child Health Hospital (a large maternal and child health care hospital in the south-east) were underweight, indicating that perinatal health care in this region should not solely focus on overweight and obese women but should also emphasize providing nutritional guidance for potentially malnourished women. In addition to advanced maternal age and obesity, patients with prepregnancy CH, diabetes mellitus, autoimmune disease, or chronic kidney disease are also at high risk for HDP. At the only general hospital included in this study, namely, Peking University First Hospital, there was a significantly higher proportion of comorbidities (e.g., CH) in HDP patients than in HDP patients in the other 2 specialized maternal and child health care hospitals. On the one hand, this is because the maternal health care system in China requires that patients with these comorbidities receive prenatal care in tertiary general hospitals with multidisciplinary consultation capabilities; therefore, there are many patients referred to Peking University First Hospital. On the other hand, this is a result of decision-making by the patient. Specifically, although

specialized maternal and child health care hospitals have the ability to handle obstetric and pediatric diseases, their lack of ability to conduct multidisciplinary consultations may not be conducive to the treatment of these comorbidities during pregnancy; therefore, patients with comorbidities before pregnancy tend to choose to receive prenatal care and undergo delivery at general hospitals. This patient distribution is beneficial for the patient in terms of receiving proper medical care. Specifically, patients with comorbidities who receive prenatal care at Peking University are advised to receive preconception care during which their commodities can be optimized before becoming pregnant. When they become pregnant, they are registered for prenatal care in the first trimester so that prophylactic therapy can be started in women with high-risk factors for developing preeclampsia. At the same time, this distribution of patients requires general hospitals, which are also tertiary health care institutions, to establish a complete multidisciplinary consultation mechanism to ensure that obstetricians and doctors in related departments can communicate in a timely and effective

Table 3. Fetal/Neonatal outcome of 1,340 pregnancy complicated by hypertensive disorders across the three Chinese regions.

	A	B	C	αp	βp	γp
No. of HDP	346	943	51			
Twin pregnancy	45 (13.0%)	104 (11.0%)	4 (7.8%)	0.33	0.30	0.48
Gestational weeks at delivery (twin pregnancy) (weeks)						
<28	0	0				
28–33 ⁺⁶	2 (4.4%)	10 (9.6%)	0	0.46	-	-
34–36 ⁺⁶	17 (37.8%)	49 (47.1%)	2 (50%)	0.29	-	-
≥37	26 (57.8%)	45 (43.3%)	2 (50%)	0.10	-	-
Total number of fetuses	391	1047	55			
Live birth infants [n (%)]	374 (95.7%)	1035 (98.9%)	55 (100%)	<0.01	0.23	-
Gestational weeks at delivery (live infants)						
<28	7 (1.9%)	1 (0.1%)	0	-	-	-
28–33 ⁺⁶	44 (11.8%)	94 (9.1%)	0	0.13	-	-
34–36 ⁺⁶	76 (20.3%)	204 (19.7%)	8 (15.7%)	0.8	0.31	0.35
≥37	247 (66.0%)	736 (71.1%)	47 (84.3%)	0.07	<0.01	0.02
Neonatal death [n (%)]	17%	12%	0%	<0.01	0.23	-
<28	15	2	0			
28–33 ⁺⁶	2	8	0			
34–36 ⁺⁶	0	2	0			
FGR	57 (15.2%)	97 (9.4%)	5 (9.1%)	<0.01	0.23	0.94
Birth weight of Live birth infants						
<1500 g	35 (9.3%)	54 (5.2%)	0	<0.01	-	-
1500–2500 g	102 (27.3%)	208 (20.1%)	9 (16.4%)	<.01	0.08	0.50
2500 g–4000 g	227 (60.7%)	740 (71.5%)	43 (78.2%)	<0.01	0.01	0.28
≥4000 g	10 (2.7%)	33 (3.2%)	3 (5.4%)	0.62	0.48	0.60

Abbreviations: HDP: hypertension disorders in pregnancy, FGR: fetal growth restriction.

 α : A v.s. B; A v.s. C; B v.s. C.

manner; otherwise, perinatal health care for HDP patients with comorbidities will be a mere formality, greatly reducing the quality of health care.

The HDP incidence at both Peking University First Hospital and Fujian Maternal and Child Health Hospital ranged from 5 to 6%, which was basically consistent with the commonly reported incidence rates of HDP (1–6). However, the incidence of HDP at the Maternal and Child Health Hospital of Ningxia Hui Autonomous Region was significantly lower than that at the other 2 hospitals, a finding that is related to the level of the hospital (a secondary maternal and child health care hospital) and the high referral rate of patients with early-onset SPE and patients with PE at high risk of preterm birth to other hospitals. Notably, although the incidence of HDP at Peking University First Hospital and Fujian Maternal and Child Health Hospital was similar, significantly more deliveries were performed at Fujian Maternal and Child Health Hospital (a central regional hospital specialized in maternal and child health). As a result, 70.4% (943/1340) of the HDP cases included in this study occurred at this hospital, indicating that in HDP prevention, the sole focus should not be only on “obviously” high-risk women with comorbidities in general hospitals but rather high-quality prenatal care for general-risk women in maternal and child health care hospitals should also be established, as this is of great significance for reducing the risk and severity of HDP (18–22).

In terms of maternal pregnancy outcomes, there were no maternal deaths during the study period, but general hospitals categorized as tertiary care institutions had a much higher incidence of serious adverse pregnancy outcomes than did specialized hospitals, a finding that is related to the difference in the severity of the patients admitted to these 2 types of hospitals. In fact, this situation is conducive to the supply of high-quality medical resources to treat critically ill patients. In addition, specialized hospitals and secondary maternal and child health care hospitals are required to have sufficient knowledge of the severity of HDP to ensure that critically ill pregnant women can receive accurate early identification and referral (23,24).

Although HDP is a very familiar disease for obstetricians, high-risk factors need to be identified, and effective perinatal health care should be provided to reduce the incidence of PE, delay early-onset PE, and improve perinatal outcomes (25–27). To achieve this goal, the identification of high-risk factors for HDP, the precautions for prenatal care, the signs of PE, and other related clinical precautions should be taught to doctors through systematic training, with this information also provided to patients through effective education. This training process should not merely be generalized and implemented via dogmatic indoctrination but should be set up based on the regional and population characteristics of the patients admitted to the hospital. For example, a comprehensive multidisciplinary consultation system should be established in general

tertiary maternal care centers to build a bridge between different disciplines. Although the proportion of women at high risk for HDP is relatively low in regional maternal and child hospitals, special care departments (e.g., nutrition clinics) should be established in these hospitals to provide systematic and high-quality prenatal care services for obese or emaciated women without a high-risk factor for HDP. For secondary maternal and child health care institutions, while further improving the quality of prenatal care, attention should be given to the early identification of critical conditions of HDP to ensure maternal and perinatal safety through timely referrals.

There are certain limitations in this study. First, only 3 hospitals were included in the study, and thus, the results cannot fully represent the clinical characteristics of patients with HDP in hospitals in various regions and of different levels. However, due to the representativeness of the 3 hospitals, the results still provide an important reference for determining the necessity of providing perinatal health care services to different pregnancy populations. Second, as a retrospective study, this study cannot directly prove that improving the quality of prenatal care can improve the pregnancy prognosis of patients with HDP, especially patients with PE. However, related research has demonstrated the significance of improving the quality of prenatal care for improving pregnancy outcomes in high-risk women on the basis of paying attention to the number of perinatal examinations (18–22).

Conclusion

In hospitals of different levels and in different regions, patients with HDP have unique demographic characteristics and high-risk factors. Therefore, targeted prenatal care procedures should be established based on regional characteristics and the characteristics of health care receivers at each hospital to improve the quality of perinatal health care and reduce the incidence of HDP.

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Data availability statement

The data that support the findings of this study are available from the corresponding author Yingdong He, upon reasonable request.

Author's contributions

Study design: He Yingdong; Data collection: Ma Rui, Huang Liping, Wang Yanmin, Zhao Tingting, Chen Shi; Data analysis: Ma Rui, Huang Liping; Manuscript preparation: Ma Rui, Huang Liping, He Yingdong. Manuscript editing and review: He Yingdong.

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