


Morbidity and maternal and infant outcomes of hypertensive disorder in pregnancy in China in 2018

Xin Lyu MD Student¹  | Weiyuan Zhang MD² | Jingxiao Zhang MD³ | Yuqian Wei MD⁴ | Xiaoli Guo MD⁵ | Shihong Cui MD⁶ | Jianying Yan MD⁷ | Xiaoyan Zhang MD⁸ | Chong Qiao MD⁹ | Rong Zhou MD¹⁰ | Weirong Gu MD¹¹ | Xianxia Chen MD¹² | Yang Zi MD¹³ | Xiaotian Li MD¹¹ | Yanyan Song MD¹⁴ | Jianhua Lin MD¹

¹School of Medicine, Renji Hospital, Shanghai Jiaotong University, Shanghai, China

²Beijing Obstetrics and Gynecology Hospital, Capital Medical University, Beijing, China

³The Fourth Hospital of Shijiazhuang, Shijiazhuang, China

⁴Affiliated Hospital of Jining Medical University, Jining, China

⁵Changzhi Maternity and Child Health Care Hospital, Changzhi, China

⁶The Third Affiliated Hospital of Zhengzhou University, Zhengzhou, China

⁷Fujian Maternity and Child Health Care Hospital, Fuzhou, China

⁸The First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

⁹Shengjing Hospital Affiliated of China Medical University, Shenyang, China

¹⁰West China Second University Hospital, Sichuan University, Chengdu, China

¹¹Fudan University Affiliated Hospital of Obstetrics and Gynecology, Shanghai, China

¹²Anhui Women and Child Health Care Hospital, Hefei, China

¹³Peking University Third Hospital, Beijing, China

¹⁴School of Medicine, Shanghai Jiaotong University, Shanghai, China

Correspondence

Jianhua Lin, MD, Department of Obstetrics and Gynecology, Renji Hospital, School of Medicine, Shanghai Jiaotong University, No. 1630, Dongfang Road, Shanghai 200127, China.
Email: linjhuarj@126.com

Funding information

None.

Abstract

Hypertensive disorder in pregnancy is a disease that occurs during pregnancy. We aimed to analyze the morbidity and maternal and infant outcomes with respect to the hypertensive disorder in pregnancy in China in 2018. Clinical data of 38 590 cases from 161 hospitals were retrospectively collected. The differences in morbidity and maternal and infant mortality among the major regions and provinces were compared. The overall national average morbidity was 4.74%, and the ratios of gestational hypertension, preeclampsia, eclampsia, chronic hypertension, and chronic hypertension with superimposed preeclampsia were 29.17%, 55.02%, 0.66%, 6.53%, and 8.62%, respectively. The overall maternal mortality was 0.61/100 000, and the case fatality was 0.13%. Morbidity associated with hypertensive disorder in pregnancy was 7.74% in North China, 6.62% in Northwest China, 6.40% in Central China, 5.83% in Northeast China, 4.28% in East China, 3.85% in South China, and 2.88% in Southwest China. The morbidity in each province was 1.62–11.28%. The overall perinatal mortality was 3.59% (81.09% for stillbirths; 18.91% for neonatal deaths). Perinatal mortality decreased with increasing gestational weeks from 24 to 37 + 6 weeks. Perinatal mortality for delivery at 32 weeks of gestation in all regions of the country was <10%. Morbidity varied across regions in China, with the lowest in Southwest and the highest in North China. The low maternal mortality is related to the large-scale development of standardized maternal health care in China. For severe hypertensive disorder patients, gestation should be prolonged to 32 weeks as often as possible for better neonatal survival rates.

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1 | INTRODUCTION

Hypertensive disorder of pregnancy (HDP) is a special disease, primarily characterized by an increase in blood pressure that occurs in pregnant women. It is often accompanied by functional damage of organs such as the heart, liver, kidney, and brain as well as the hematologic system unless it is treated in a timely and effective manner. It also affects intra-uterine growth and fetal development, resulting in premature delivery, fetal death, and stillbirth. Maternal-fetal safety is endangered in severe cases. Currently, HDP is the main cause of maternal and perinatal morbidity and mortality, especially in developing countries.¹

Morbidity and mortality of HDP vary widely depending on the region. A study by Umesawa et al showed that morbidity of HDP was 5.2%–8.2%.² There are 600 000 maternal deaths worldwide every year, of which more than 70 000 (12%) are due to preeclampsia and eclampsia. Though the morbidity and mortality of HDP have been greatly reduced in developed countries, it remains a problem in developing countries. The average morbidity reported in a large sample survey of HDP from 1988 to 1989 in China was 9.4%.³ HDP maternal deaths include hemorrhagic stroke, cardiac and respiratory arrest, disseminated intravascular coagulation, adult respiratory distress syndrome, renal failure, liver hemorrhage, and hypoxic-ischemic encephalopathy. The risk of severe complications in patients with preeclampsia and eclampsia increases by 3–25-fold for pulmonary edema, placental abruption, aspiration pneumonia, renal failure, liver failure, disseminated intravascular coagulation (DIC), and stroke.¹ China is a large country with 15.20 million deliveries in 2018.⁴ Presently, HDP threatens the lives and health of mothers and infants. The morbidity of HDP in China is mostly recorded in single-center studies, and there are no large-scale, multicenter research data, making it difficult to draw horizontal comparisons across regions. Therefore, we collected data from many centers across different regions of China to analyze morbidity and maternal and infant outcomes associated with HDP.

2 | MATERIALS AND METHODS

2.1 | Research objective

Under the leadership of the hypertensive disorder in pregnancy group of the obstetrics and gynecology department of the Chinese Medical Association, the project was designed by the obstetrics and gynecology department of Renji Hospital affiliated with Shanghai Jiaotong University School of Medicine. National second- and third-level general hospitals and hospitals specializing in obstetrics and gynecology participated in the project voluntarily. The participating units must have had an annual delivery volume of more than 1000 cases, an annual number of HDP of more than 30 cases, and a complete data for 2018. Finally, a total of 38 590 cases of hypertensive disorder complicating pregnancy were collected from 161 hospitals (including five branches) in 24 provinces from January 1 to December 31, 2018. During the same period, there were 814 376 deliveries and 39 527 newborns.

2.2 | Diagnostic criteria

We referred to the 2015 guideline for the diagnosis and treatment of hypertensive disorders in pregnancy in China.⁵ This study defined HDP and classified it into five categories: gestational hypertension (GH), preeclampsia (including past, mild, and severe), eclampsia, chronic hypertension, and chronic hypertension with superimposed preeclampsia. Specific diagnostic criteria are shown in Table S1.

2.3 | Research method

Throughout 2018, we retrospectively collected the basic information, including disease types, gestational weeks at delivery, neonatal conditions, maternal and infant outcomes, and the total number of hospital deliveries, of patients diagnosed with HDP. There are 34 provincial administrative units in China: 23 provinces, 4 municipalities directly under the central government, 5 autonomous regions, and 2 special administrative regions. We calculated the morbidity, maternal mortality, and neonatal outcomes with respect to HDP in various units, provinces, regions, and the country. The study was approved by the Renji Hospital Ethics committee and adhered to the principles of the Declaration of Helsinki.

2.4 | Statistical methods

Using IBM SPSS Statistics 26 (Chicago, IL, USA) and SAS 9.4 software package (SAS Institute Inc, Cary, NC, USA), the measurement data are expressed as the mean \pm standard deviation. The Wilcoxon rank-sum test was used to compare the two groups, Kruskal-Wallis test (K-W) to compare multiple groups, and chi-square test to compare the rates across nominal categories. The Cochran-Armitage trend test was used to test whether proportions increased or decreased across ordered groups. A p -value $< .05$ was considered significant.

3 | RESULTS

3.1 | General information of pregnant women and states of multicenter hospitals

3.1.1 | Epidemiological characteristics of pregnant women

We found that basic information of pregnant women, including age, nationality, obesity rate, household registration, and standardized birth inspection rates, in the seven major regions were different ($p < .01$, K-W test was used for age comparison, and chi-square test was used for the comparison of other general information). Compared with those in other regions, the differences in ethnic minorities' rate in the Northwest region, obesity rates in the Northeast region, and the standardized birth examination rate in Central China all reached difference ($p < .01$, chi-square test) (Table 1).

TABLE 1 Characteristics of research population

	East China	North China	Central	South China	Northeast	Southwest	Northwest	Nationwide
Age (years) (n)	31.07 ± 5.449 (8659)	30.75 ± 4.876 (7669)	30.80 ± 5.473 (3953)	31.87 ± 5.567 (11 257)	31.34 ± 5.203 (2510)	31.80 ± 5.310 (2379)	31.46 ± 5.198 (1958)	31.29 ± 5.345 (38 385)
Nationality [% (n)]								
Han	96.8 (8374)	92.9 (7122)	98.4 (4029)	95.1 (10 715)	90.8 (2262)	91.8 (2187)	64.4 (1261)	93.3 (35 950)
Hui	2.7 (237)	2.2 (167)	1.0 (41)	2.5 (283)	1.6 (40)	2.3 (55)	10.9 (214)	2.7 (1037)
Other	0.5 (44)	5.0 (381)	0.6 (25)	2.3 (264)	7.6 (190)	5.9 (140)	24.7 (484)	4.0 (1528)
Obesity rate ^a [% (n)]	20.8 (1324)	24.2 (1379)	20.0 (648)	14.4 (1316)	35 (565)	22.7 (497)	27.0 (346)	20.6 (6075)
Household registration [% (n)]								
City	51.7 (4153)	52.0 (3887)	50.7 (2054)	55.0 (5759)	67.8 (1462)	62.3 (1478)	56.3 (11 001)	54.5 (19 894)
Countryside	38.9 (3125)	39.7 (2964)	42.3 (1715)	37.7 (3948)	26.5 (572)	32.4 (770)	38.7 (757)	37.9 (13 851)
Urban-rural fringe	9.5 (761)	8.3 (623)	7.0 (285)	7.3 (765)	5.7 (123)	5.3 (126)	5.0 (98)	7.6 (2781)
Standardized birth inspection rate ^b [% (n)]	85.3 (7364)	82.2 (5478)	69.0 (2798)	84.4 (9480)	86.7 (2127)	90.3 (2153)	75.9 (1483)	82.6 (300 883)

^aObesity rate: The definition of obesity is BMI ≥ 28 kg/m²; ^bStandardized birth inspection rate: According to the current health care situation during pregnancy and the need for prenatal examination items in China, 11 prenatal examinations during pregnancy are recommended, and those with high-risk factors should undergo a higher number of examinations as appropriate. The definition of standardized birth inspection rate is the percentage of pregnant women who complete the above examination items on time during pregnancy.

3.1.2 | Level and type of hospital

We collected data from 161 medical institutions in 24 provinces across the country, including 140 third-level hospitals (86.96%) and 21 second-level hospitals (13.04%). According to the classification of hospitals, there were 129 general hospitals (80.75%) and 31 obstetrics and gynecology specialized hospitals (19.25%).

3.2 | Morbidity and composition ratio of morbidity

3.2.1 | Overall morbidity and composition ratio of morbidity in China

The national overall HDP morbidity was 4.74%, and the rates of hypertensive disorder complicating pregnancy, preeclampsia, eclampsia, pregnancy complicated with chronic hypertension, and chronic hypertension complicated with preeclampsia were 29.17%, 55.02%, 0.66%, 6.53%, and 8.62%, respectively. The morbidity rates were 1.38%, 2.61%, 0.03%, 0.31%, 0.41%, respectively.

3.2.2 | Morbidity and composition ratio of morbidity by 7 major regions

There were differences in morbidity among the major regions, with the highest rate in North China (7.74%) and the lowest rate in Southwest China (2.88%). Among the several subtypes of HDP, preeclampsia accounted for the highest proportion, followed by GH, chronic hypertension with superimposed preeclampsia, and pregnancy complicated with chronic hypertension. While the nationwide preeclampsia ratio of HDP was 55.02%, it was 64.6% and 74.4% in the Northwest and Northeast regions, respectively. The morbidity of eclampsia was the lowest, and the proportion of other regions except Northwest China was less than 1% of the total number of cases (Table 2).

3.2.3 | Provinces with high and low morbidity

China has 34 provincial administrative units. According to the statistics collected from 24 provinces, the range of morbidity was 1.62%–11.28%, with the lowest rates in the provinces of Chongqing, Fujian, Zhejiang, Shandong, and Guangdong. The five provinces with the highest morbidities were Shanxi, Jilin, Hebei, Xinjiang, and Hainan (Table 3).

3.3 | Gestational weeks and perinatal outcomes

3.3.1 | National perinatal outcomes

This study was based on the ICD-10 definition of the perinatal period and statistics on perinatal infants who reached 22 weeks of gestation. Reported mortalities are shown in Table 4. The overall rate

TABLE 2 Morbidity of HDP in 7 major regions [n (%)]

Area	Annual delivery volume	HDP	Gestational hypertension	Preeclampsia	Eclampsia	Pregnancy with chronic hypertension	Chronic hypertension with superimposed preeclampsia
East China	203 323	8710 (4.28)	2829 (1.39)	4531 (2.23)	46 (0.02)	584 (0.29)	720 (0.35)
North China	99 100	7669 (7.74)	2141 (2.16)	4152 (4.19)	35 (0.04)	657 (0.66)	684 (0.69)
Central China	63 960	4093 (6.40)	1227 (1.92)	2255 (3.53)	36 (0.06)	232 (0.36)	343 (0.54)
South China	292 766	11 269 (3.85)	3625 (1.24)	5896 (2.01)	86 (0.03)	763 (0.26)	899 (0.31)
Northeast	43 038	2511 (5.83)	370 (0.86)	1843 (4.28)	13 (0.03)	69 (0.16)	216 (0.50)
Southwest	82 629	2382 (2.88)	609 (0.74)	1291 (1.56)	15 (0.02)	163 (0.20)	304 (0.37)
Northwest	29 560	1956 (6.62)	454 (1.54)	1263 (4.27)	25 (0.08)	53 (0.18)	161 (0.54)

of perinatal mortality nationwide was 3.59%. The comparisons between the upper and lower groups are shown in Table 4. There were no significant differences in perinatal death rates at <26 weeks or >38 weeks of gestation. The Cochran-Armitage trend test showed that perinatal mortality decreased across gestational weeks ($p < .01$) (Figure 1). According to the Cochran-Armitage test, the statistical z value of perinatal mortality was -24.33 ($p < .001$), indicating that perinatal mortality decreased across gestational weeks.

3.3.2 | Perinatal outcomes across 7 major regions

Perinatal outcomes were compared across 7 major regions (Tables 5). There were no differences in mortality across regions for infants with less than 28 weeks or more than 36 weeks of gestation. The perinatal mortality for 28–35 + 6 weeks and 28–33 + 6 weeks of pregnancy differed across regions. The perinatal mortalities for 28–29 + 6 weeks of pregnancy in Southwest, Northwest, North China were 55.74%, 45.9%, 42.45%, respectively, which were higher than the national average ($p < .05$). And the perinatal mortality in East China were 19.33%, which was lower than the national average ($p < .05$). The perinatal mortalities at 30–31 + 6 weeks of pregnancy in East and Southwest China were 7.42% and 37.50%, which were different when compared with the national average. The perinatal mortality of East China was lower than the national average and the Southwest China was higher than the national average ($p < .01$). The difference in perinatal mortality at 32–33 + 6 weeks of pregnancy between East China and nationwide reached significance ($p < .01$). The perinatal mortality for 34–35 + 6 weeks of pregnancy differed across regions, though there were no differences across the individual regions and at the country level.

3.4 | Comparison of the stillbirth rate and live birth neonatal mortality

Regarding outcomes for all perinatal infants, stillbirths accounted for 81.09% (1145/1412) of perinatal infant deaths, and neonatal death accounted for 18.91% (267/1412). The mortality of neonates born alive in China was 0.70%, with the lowest in South China (0.46%), followed by East China (0.47%). The highest mortality was 1.50% in Northeast China, followed by 1.27% in Southwest China (Table 6).

3.5 | Maternal mortality

The total number of deliveries in the investigation unit was 814 376, and the total number of HDP cases was 38 590. Five patients died of the disease. There were two patients in South China, one in the Northeast, one in the Northwest, and one in the Southwest. The overall mortality rate was 0.61/100 000, and the case fatality was 0.13%. The causes for the five deaths are listed in Table S2.

TABLE 3 Provinces with higher and lower morbidity

	Provinces	Region	Total delivery (n)	Number of cases (n)	Incidence rate (%)
The five provinces with the lowest morbidity	Chongqing	Southwest	49 966	810	1.62
	Fujian province	South China	169 505	6105	3.60
	Zhejiang province	East China	23 230	922	3.97
	Shandong province	North China	59 732	2373	3.97
	Guangdong province	South China	111 802	4455	3.98
The five provinces with the highest morbidity	Hainan province	South China	4991	335	6.71
	Xinjiang Uygur autonomous region	Northwest	20 034	1394	6.96
	Hebei province	North China	28 137	1974	7.02
	Jilin province	Northeast	6790	568	8.37
	Shanxi province	North China	22 674	2558	11.28

Pregnant week of delivery	Number of perinatal infants	Perinatal mortality (%)	p-value (compared with previous row)	
22-23 + 6	124	100	-	-
24-25 + 6	229	99.11	.291	1.114
26-27 + 6	408	77.43	<.001	53.678
28-29 + 6	871	33.03	<.001	221.289
30-31 + 6	1393	13.28	<.001	126.570
32-33 + 6	2387	4.61	<.001	91.949
34-35 + 6	4536	1.61	<.001	54.657
36-37 + 6	9661	0.46	<.001	50.286
38-39 + 6	14 810	0.26	.009	6.923
≥40 weeks	4882	0.18	.370	0.805
Total	39 301	3.59	-	-
p for trend			<.001	-24.329

TABLE 4 Perinatal mortality rate in different pregnant weeks of delivery in China

4 | DISCUSSION

4.1 | Morbidity of hypertensive disorder complicating pregnancy

The morbidity of HDP varies widely worldwide: 0.5%–2.3% in Africa, 0.2%–6.7% in Asia, 2.8%–9.2% in Oceania, 2.8%–5.2% in Europe, 2.6%–4.0% in North America, and 1.8%–7.7% in South America and the Caribbean.² Among the various subtypes of HDP, the highest is preeclampsia, which is 2.61%, and it accounts for 55.02% of the total cases. Abalos⁶ studied statistics on the morbidity of preeclampsia worldwide, reporting that the overall morbidity of preeclampsia is 2.3%, with the lowest being located in the Eastern Mediterranean region with 1.2% and the highest morbidity in the western Pacific region with 4.2%, followed by Africa and Europe with 4.0% and 3.8%, respectively. However, due to the limitation of data collection, the author estimated the morbidity of preeclampsia to be approximately 5% by constructing a model.

Our study collected data from obstetrics departments in 161 (including five branch hospitals) hospitals of 24 provincial administrative units in China. The overall morbidity was 4.74% (38 590/814 376). The average morbidity reported in the large sample survey from 1988 to 1989 was 9.4% (including mild, moderate, and severe preeclampsia, eclampsia, and chronic hypertension with superimposed preeclampsia).³ The national survey of HDP reported a morbidity of 5.22% in 2011.⁷ The morbidity was lower than that in 1988. This may be affected by the factors such as increased awareness of diseases among pregnant women, improvement in preventive measures, emphasis on pre-pregnancy health care, and improvement in living standards. The subtype with the lowest morbidity in this study was eclampsia, with a morbidity of 0.03%. The morbidity of eclampsia reported in the 1988–1989 survey was 2.6%, which was higher than this study. This is closely related to the improvement in medical technology, prevention and treatment of non-eclampsia, and close patient monitoring.

According to statistics, morbidity varies across China. The lowest morbidity was 2.88% in Southwest China, of which Chongqing

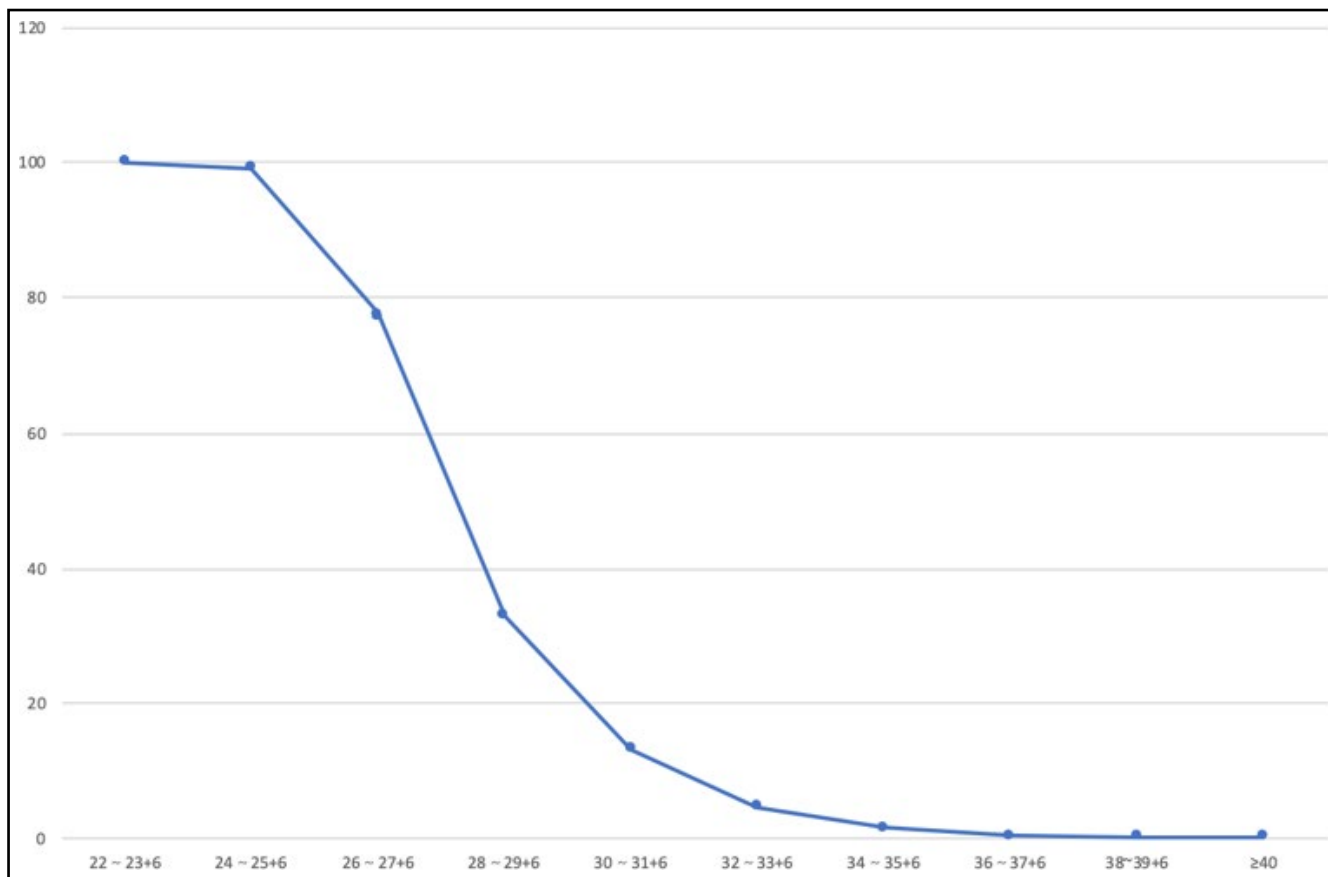


FIGURE 1 This study was based on the ICD-10 definition of the perinatal period and statistics on perinatal infants who have reached 22 weeks of gestation. The Cochran-Armitage Trend Test showed perinatal mortality decrease across gestational weeks ($p < .01$) as shown in Figure 1. According to the Cochran-Armitage test method, the statistical z value of perinatal mortality is -24.33 ($p < .001$), indicating that perinatal mortality decreased across gestational weeks [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 5 Number of perinatal deaths and mortality by region and gestation week of delivery (%)

By week	East China	North China	Central China	South China	Northeast	Southwest	Northwest	p
22-23 + 6	15 (100%)	25 (100%)	17 (100%)	29 (100%)	13 (100%)	15 (100%)	10 (100%)	-
24-25 + 6	30 (93.75%)	44 (100%)	28 (100%)	59 (100%)	23 (100%)	17 (100%)	21 (100%)	0.097
26-27 + 6	55 (82.09%)	52 (74.29%)	47 (77.05%)	80 (69.57%)	29 (82.86%)	28 (93.33%)	28 (82.35%)	0.105
28-29 + 6	29 (19.33%)	59 (42.45%)	56 (28.57%)	58 (30.85%)	24 (31.17%)	34 (55.74%)	28 (45.9%)	<0.001
30-31 + 6	19 (7.42%)	30 (12.88%)	28 (10.18%)	36 (11.65%)	15 (12.82%)	36 (37.5%)	21 (19.63%)	<0.001
32-33 + 6	7 (1.64%)	15 (3.8%)	14 (3.66%)	42 (6.33%)	12 (6.12%)	13 (8.28%)	7 (4.24%)	0.003
34-35 + 6	8 (0.81%)	14 (1.78%)	11 (1.92%)	15 (1.22%)	11 (2.96%)	9 (2.88%)	5 (1.77%)	0.042
36-37 + 6	7 (0.35%)	7 (0.38%)	7 (0.69%)	13 (0.44%)	3 (0.45%)	3 (0.44%)	4 (0.77%)	0.796
38-39 + 6	6 (0.17%)	7 (0.23%)	4 (0.31%)	9 (0.2%)	3 (0.42%)	7 (0.67%)	2 (0.31%)	0.764
≥40 weeks	1 (0.08%)	1 (0.09%)	1 (0.24%)	3 (0.19%)	1 (0.63%)	1 (0.45%)	1 (0.44%)	0.584
Total	177 (2.05%)	254 (3.30%)	213 (5.04%)	344 (2.95%)	134 (5.66%)	163 (6.16%)	127 (6.12%)	<0.001

had the lowest morbidity (1.62%). The highest morbidity was 7.74% in North China, with Shanxi Province having the highest morbidity (11.28%). This is followed by 6.62% in Northwest and 6.4% in Central China. The management of pregnant women varies regionally. The coverage of pregnancy health care in some economically

underdeveloped areas is relatively low, and patients' awareness is poor. Chongqing, as one of the municipalities directly under the central government of China, has a dual economic structure with large cities and large rural areas. As the municipality is directly under the central government, maternal and child health care

TABLE 6 Number of stillbirths and neonatal deaths and mortality by region

By week	Central China							Nationwide
	East China	North China	China	South China	Northeast	Southwest	Northwest	
Stillbirth								
22-23 + 6	15 (100%)	24 (96%)	17 (100%)	29 (100%)	12 (92.31%)	15 (100%)	10 (100%)	122 (98.39%)
24-25 + 6	27 (84.38%)	41 (93.18%)	28 (100%)	54 (91.53%)	20 (86.96%)	16 (94.12%)	20 (95.24%)	206 (91.96%)
26-27 + 6	43 (64.18%)	47 (67.14%)	41 (67.21%)	69 (60%)	25 (71.43%)	22 (73.33%)	25 (73.53%)	272 (66.02%)
28-29 + 6	20 (13.33%)	46 (33.09%)	36 (18.37%)	46 (24.47%)	15 (19.48%)	25 (40.98%)	24 (39.34%)	212 (24.31%)
30-31 + 6	12 (4.69%)	20 (8.58%)	17 (6.18%)	29 (9.39%)	10 (8.55%)	26 (27.08%)	13 (12.15%)	127 (9.12%)
32-33 + 6	5 (1.17%)	12 (3.04%)	7 (1.83%)	34 (5.12%)	8 (4.08%)	8 (5.1%)	7 (4.24%)	81 (3.39%)
34-35 + 6	6 (0.61%)	9 (1.14%)	8 (1.4%)	12 (0.98%)	5 (1.34%)	9 (2.88%)	4 (1.41%)	53 (1.17%)
36-37 + 6	5 (0.25%)	7 (0.38%)	6 (0.6%)	13 (0.44%)	3 (0.45%)	2 (0.29%)	2 (0.39%)	38 (0.39%)
38-39 + 6	3 (0.09%)	6 (0.2%)	4 (0.31%)	4 (0.09%)	1 (0.14%)	7 (0.67%)	1 (0.15%)	26 (0.18%)
≥40 weeks	1 (0.08%)	1 (0.09%)	1 (0.24%)	2 (0.13%)	1 (0.63%)	1 (0.45%)	1 (0.44%)	8 (0.16%)
Total	137 (1.59%)	213 (2.77%)	165 (3.9%)	292 (2.5%)	100 (4.22%)	131 (4.95%)	107 (5.15%)	1145 (2.91%)
Newborn death								
22-23 + 6	0 (/)	1 (100%)	0 (/)	0 (/)	1 (100%)	0 (/)	0 (/)	2 (100%)
24-25 + 6	3 (60%)	3 (100%)	0 (/)	5 (100%)	3 (100%)	1 (100%)	1 (100%)	16 (88.89%)
26-27 + 6	12 (50%)	5 (21.74%)	6 (30%)	11 (23.91%)	4 (40%)	6 (75%)	3 (33.33%)	47 (33.57%)
28-29 + 6	9 (6.92%)	13 (13.98%)	20 (12.5%)	12 (8.45%)	9 (14.52%)	9 (25%)	4 (10.81%)	76 (11.52%)
30-31 + 6	7 (2.87%)	10 (4.69%)	11 (4.26%)	7 (2.5%)	5 (4.67%)	10 (14.29%)	8 (8.51%)	58 (4.58%)
32-33 + 6	2 (0.47%)	3 (0.78%)	7 (1.87%)	8 (1.27%)	4 (2.13%)	5 (3.36%)	0 (0%)	29 (1.26%)
34-35 + 6	2 (0.2%)	5 (0.64%)	3 (0.53%)	3 (0.25%)	6 (1.63%)	0 (0%)	1 (0.36%)	20 (0.45%)
36-37 + 6	2 (0.1%)	0 (0%)	1 (0.1%)	0 (0%)	0 (0%)	1 (0.15%)	2 (0.39%)	6 (0.06%)
38-39 + 6	3 (0.09%)	1 (0.03%)	0 (0%)	5 (0.11%)	2 (0.28%)	0 (0%)	1 (0.15%)	12 (0.08%)
≥40 weeks	0 (0%)	0 (0%)	0 (0%)	1 (0.06%)	0 (0%)	0 (0%)	0 (0%)	1 (0.02%)
Total	40 (0.47%)	41 (0.55%)	48 (1.18%)	52 (0.46%)	34 (1.5%)	32 (1.27%)	20 (1.02%)	267 (0.7%)

has been strengthened and medical resources have increased. Nevertheless, there remain problems, such as poor infrastructure, insufficient equipment, low economic and social benefits for maternal and child health care institutions, and insufficient service capacity of maternal and child health care institutions, in the growing medical and health care needs of the masses. Moreover, patients in rural areas have poor awareness of seeking medical treatment, lack of reasonable management, and missed diagnosis of HDP patients. The low morbidity in this area may be related to these problems. Shanxi Province, which has the highest morbidity, is an inland province. It is located in the Loess Plateau region. Wang⁸ conducted a study on HDP in the plateau region and suggested that the high altitude may give rise to greater morbidity and maternal and perinatal mortality due to factors such as cold, dryness, and low oxygen tension at high altitudes. This suggests that regional factors play roles in the causes of increased morbidity in Shanxi Province. Among the five subtypes of HDP, preeclampsia is the most common in all regions, and the morbidity of eclampsia is the lowest. We know that GH and pregnancy complicated with chronic hypertension are usually manifested only by elevated blood pressure, whereas preeclampsia is often accompanied by damage to other organs. The morbidity of GH and pregnancy complicated with chronic hypertension in Northeast and Northwest regions is lower than that in other regions, the morbidity of PE is higher than that in other regions, indicating that diseases in these regions are more likely to be accompanied by damage to other organs. Studies have shown that obese pregnant women are more likely to have preeclampsia than normal weight pregnant women.⁹ For every increase in BMI of 5–7 kg/m², the risk of preeclampsia for patients doubles.¹⁰ In addition, it may also be related to factors, such as the level of medical care, monitoring of patients, and early intervention.

Based on the analysis of the collected data and the basic information of the population, we found differences across various regions. Follow-up studies of patients with hospital deliveries in Shanghai from 1989 to 1998 showed an average morbidity of 5.57%.¹¹ A multicenter, prospective clinical study on HDP conducted by the national “Tenth Five-Year Plan” research project showed an average morbidity of 3.91% in 24 tertiary hospitals in 11 provinces and cities nationwide from April 2005 to July 2006.¹² A study by the People's Hospital of Tibet Autonomous Region on 318 pregnant women who gave birth between March 2011 and March 2012 showed that the morbidity of HDP was 7.23%.¹³ In this study, the Northwest, Northeast, and Southwest regions included the gathering places of ethnic minorities in our country; therefore, the rate of ethnic minorities was higher than that in other regions. Owing to long-term dietary differences across China, the obesity rate in the Northern region is generally higher than that in the Southern region. Regarding the management of pregnant women, there are substantial differences across the country, such as in Henan Province, located in Central China. Because it is a major agricultural province, there are more pregnant women distributed in rural areas, and local standard birth inspection cannot be well popularized. Only high-risk pregnant

women visit provincial capital cities temporarily for treatment, thereby reducing the standardized birth inspection rate. There are a large number of rural and floating populations in China. The management of these patients remains a problem because of their greater mobility, early-onset rapid progress, and heavy degree of HDP.

4.2 | Mortality due to hypertensive disorder complicating pregnancy

If HDP is not effectively controlled, it will lead to serious complications and even threaten the lives of pregnant women. It is reported that more than 70 000 patients worldwide die from HDP every year. In Latin America and the Caribbean, hypertension causes nearly 26% of maternal deaths, while in Africa and Asia, it causes approximately 9% of deaths.¹⁴ The pregnancy-related mortality of preeclampsia in California, USA, was 1.6/100 000. In the United Kingdom, the death rate from 2009 to 2013 was 0.25/100 000, and after the implementation of national guidelines, the rate dropped to 0.08/100 000 in 2012–2014.¹⁵ In the present study, there were five maternal deaths attributable to HDP, with a mortality rate of 0.61/100 000 and case fatality of 0.13%. China's control of the death rate has been among the highest worldwide and even reached the level of developed countries.

In developed countries, from 1997 to 2002, hypertension was the main cause of death, followed by embolism and hemorrhage.¹⁶ In Africa and Asia, the main cause of death was hemorrhaging, followed by infection and hypertension. In Latin America and the Caribbean, hypertension was the main cause of death, followed by hemorrhage and dystocia.^{17–19} Of the five deaths recorded in this study, two patients died of secondary intracranial lesions, one had eclampsia with blood pressure as high as 220/120 mmHg and died owing to cardiac arrest after being sent to a hospital, one died of disseminated intravascular coagulation (DIC), and one died of heart failure and severe pneumonia. According to a summary of 45 960 deliveries in India in the past 20 years (1985–2005), 50 of the 62 maternal deaths caused by hypertension were due to eclampsia stroke.²⁰ According to a statistical report on the causes of death of HELLP, the causes of maternal death include hemorrhagic stroke (45%), cardiac and respiratory arrest (40%), DIC (39%), adult respiratory distress syndrome (28%), renal failure (28%), liver hemorrhage (20%), and hypoxic-ischemic encephalopathy (16%).²¹ Owing to the small number of deaths in this study, the proportion of death causes cannot be obtained, though it is roughly consistent with the causes of death reported above.

4.3 | Perinatal outcome of hypertensive disorder complicating pregnancy

HDP is a group of placental diseases. In severe cases, the placental function is affected, resulting in fetal dysplasia, fetal growth restriction, fetal intrauterine distress, premature birth, intrauterine death, and stillbirth. It is one of the important causes of perinatal

death. Reportedly, the survival rate of babies born around 24–28 weeks of pregnancy is only 19.7%, while the survival rate of babies born around 32–34 weeks of pregnancy generally rises to 79.8%.²² This study shows that the overall perinatal mortality in China was 3.59% (of which stillbirth accounted for 81.09% and neonatal death accounted for 18.91%). The perinatal mortality for those who gave birth at 24–37 + 6 weeks of gestation showed a significant downward trend with the increase in gestational weeks. There was no significant difference in the perinatal mortality for those who gave birth at 22–23 + 6 and 24–25 + 6 weeks of gestation. On comparing regions, there was no difference in the mortality of perinatal infants with <28 and >36 weeks of gestation. The perinatal mortality during 28–31 + 6 weeks of pregnancy in Southwest China was higher than the national average. The perinatal mortality during 28–33 + 6 weeks of pregnancy in East China was lower than the national average. The perinatal mortality during 34–35 + 6 weeks of pregnancy differed across regions, though there was no significant difference across regions and at the country level.

The distribution of medical resources and living standards in China is uneven. There are substantial differences in the ability to treat premature perinatal infants across the country, especially premature infants born before 34 weeks. The perinatal mortality in East China, which is densely populated, economically developed, and rich in medical resources, has been reduced. In contrast, the perinatal mortality is relatively high in areas with relatively insufficient medical resources, such as Southwest China. In this study, the perinatal mortality was the highest in the underdeveloped Northwest and Southwest regions, while morbidity was the lowest in the relatively rich Eastern regions. Considering all regions nationwide, the perinatal mortality during delivery before 32 weeks of pregnancy was lower than 10%; the data suggest that, for severe HDP patients, gestation should be prolonged to 32 weeks as much as possible for better neonatal survival rates.

5 | SUMMARY

China is a developing country with a large population and vast territory. Differences in culture, diet, lifestyle, and other aspects, including the levels of medical care and economic status across regions, were noted. Some studies have found that the risk of preeclampsia in patients with lower educational levels was five times higher than that in patients with higher educational levels.²³ Because of the increase in resources, China has a large itinerant population, making the management of pregnant women challenging. All these problems have caused differences in incidence rates across China; these differences are key in reducing HDP morbidity and controlling disease development. On comparing different regions in China, it could be seen that in economically developed regions, such as East China, its development model was closer to that of developed countries. Owing to organized health care services and the use of advanced medical technology, the maternal lifestyle is healthier and

the maternal and neonatal mortality is equal to those of developed countries. However, in areas with relatively backward economy, such as Northwest China, owing to the common problems such as insufficient medical resources, low economic and cultural levels, and unsmooth traffic, the lack of maternal health care during pregnancy, delay in patients' receiving medical treatment, and lack of medical workers' ability to deal with critically ill patients. These are also problems faced by most developing countries. Recently, China's management with respect to pregnancy health care and the rural population has been strengthened, and the referral system for critically pregnant women has also been improved. The morbidity has also decreased over time. In 2019, the overall maternal mortality in China was 0.61/100 000, and it was 0 in East China, suggesting that these efforts were productive, though further efforts are still needed.

There are several challenges in predicting, preventing, and treating HDP in developing countries. Overcoming the challenge of controlling HDP in developing countries depends on improving the health care system and the ability to identify and manage high-risk women. The national government and supporting institutions should make efforts to strengthen the public health system, and further research is needed to understand the causes and prevention methods of HDP in specific geographical areas. According to the current data, it is very important to strengthen maternal health care during pregnancy, strengthen obstetric care during pregnancy, and enhance the management ability of high-risk patients to reduce the incidence of HDP in developing countries.

6 | LIMITATION

This study is the largest sample study of HDP in recent history in China. Due to the large population, the annual delivery volume of general second-level and third-level hospitals in China is over 1000. Only a few hospitals have less than 1000 deliveries per year. Due to their small scale, less inspection and lack of equipment, there may be deviations in the evaluation and diagnosis and treatment of HDP. Therefore, we excluded hospitals with less than 1000 deliveries per year. On the other hand, in recent years, the morbidity of HDP in China shows about 4%–7%. According to the proportion, the number of HDP cases in every 1000 delivery patients is about 40–70. Therefore, we require that the number of HDP patients participating in hospitals should not be less than 30, so as to avoid deviation. Most administrative regions of China were included, though a few provinces could not participate. The provinces of Tianjin, Gansu, Qinghai, Jiangxi, Ningxia Hui Autonomous Region, Guizhou, Tibet Autonomous Region, Hong Kong, and Macao Special Administrative Regions, and Taiwan had no units participating in the study. Therefore, our results may not represent the overall incidence in China. In addition, the number of participating units varied across regions. For example, there were fewer participants from Jilin, Heilongjiang, Hunan, and Hainan provinces, and Guangxi Zhuang Autonomous Region than from other regions. They only had

1–2 participating units, which cannot well represent the overall incidence in the region. Therefore, further studies are required to investigate comprehensive HDP epidemiological rates.

ACKNOWLEDGMENTS

In writing this paper, I would like to sincerely thank all units for participating in our study and expanding our database to make our data more representative of the incidence rate of HDP in China. Data entry is a tedious process. I am very grateful to these 161 units for actively cooperating with data entry and checking the accuracy of data carefully and repeatedly. Due to limited space, the names of all participating units and their responsible persons cannot be listed here. The top 20 units providing the largest number of cases are listed now. Top 20 Participating Units:

1. The Fourth Hospital of Shijiazhuang, Zhang Jingxiao
2. Affiliated Hospital of Jining Medical University, Wei Yuqian
3. Changzhi Maternity and Child Health Care Hospital, Guo Xiaoli
4. The Third Affiliated Hospital of Zhengzhou University, Cui Shihong
5. Fujian Maternity and Child Health Care Hospital, Yan Jianying
6. The First affiliated hospital of Zhengzhou University, Zhang Xiaoyan
7. Shengjing Hospital Affiliated of China Medical University, Qiao Chong
8. West China Second University Hospital, Sichuan University, Zhou Rong
9. Fudan University Affiliated Hospital of Obstetrics and Gynecology, Gu Weirong
10. Anhui Women and Child Health Care Hospital, Chen Xianxia
11. Shenzhen Maternity and Child Health Care Hospital, Wu Linlin
12. Huai'an Maternal and Child Health Care Hospital, Jiangsu Province, Xu Jinxia
13. The Third Affiliated Hospital of Guangzhou Medical University, He Fang
14. The Second Hospital of Jilin University, Teng Hong
15. Guangzhou Women and Children's Medical Center, Di Xiaodan
16. The International Peace Maternity and Child Health Hospital of China Welfare Institute, Fan Jianxia
17. Maternity and Child Health Care of Zaozhuang, Liu Yanhua
18. The First Affiliated Hospital of Xinjiang Medical University, Wu Jianli
19. Taiyuan Maternity and Child Health Care Hospital, Zhang Meihua
20. Yuncheng Center Hospital, Li Xiaoqin

[Correction added on 12 April 2021 after first online publication: The Acknowledgment section has been modified.]

CONFLICT OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

Xin Lyu; The first author, who participate in data sorting, analysis and paper writing. Weiyuan Zhang, Zi Yang and Xiaotian Li: The core

members of the organization that initiated the study (Hypertensive Disorder in Pregnancy group of the Obstetrics and Gynecology Department of the Chinese Medical Association). Jingxiao Zhang, Yuqian Wei, Xiaoli Guo, Shihong Cui, Jianying Yan, Xiaoyan Zhang, Chong Qiao, Rong Zhou, Weirong Gu, Xianxia Chen, Zi Yang, Xiaotian Li: Cooperating with data entry and checking the accuracy of data carefully and repeatedly. Yanyan Song: Participate in the calibration of statistics designed by this research to ensure the correctness of statistical methods. Jianhua Lin*: The corresponding author involved in data analysis and paper revision.

ORCID

Xin Lyu  <https://orcid.org/0000-0002-2260-1486>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Lyu X, Zhang W, Zhang J, et al. Morbidity and maternal and infant outcomes of hypertensive disorder in pregnancy in China in 2018. *J Clin Hypertens*. 2021;23:1194-1204. <https://doi.org/10.1111/jch.14248>