

## Preplanned Studies

## Clinical Effects of the COVID-19 Pandemic Among the Uninfected Pregnant Women — 6 PLADs, China, 2019–2020

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### Summary

#### What is already known about this topic?

The coronavirus disease 2019 (COVID-19) pandemic potentially affected prenatal care quality and maternal and fetal outcomes globally.

#### What is added by this report?

During COVID-19 pandemic period, the rates of caesarean sections (CS) and preterm birth for uninfected pregnant women increased slightly in areas that were relatively severely impacted by the pandemic in China. The overall number of prenatal examinations did not dramatically decrease, while the eligible examinations significantly decreased in Hubei Province.

#### What are the implications for public health practice?

Routine prenatal examinations had been well maintained during the pandemic period in China. In the future, in-time prenatal examinations should be provided to improve the quality of screening and management of high-risk pregnancy under pandemic-affected circumstances. Psychological counseling and transfer treatment channels should be strengthened for pregnant women during lockdown period.

The impact of the coronavirus disease 2019 (COVID-19) pandemic on pregnant women have been of considerable concern. Uninfected pregnant women may be affected by generalized social panic, reduced number of prenatal examinations (NPE)<sup>\*</sup>, and delayed medical treatment. During the COVID-19 pandemic in China, most pregnant women stayed at home unless an urgent prenatal examination or treatment was required. It was reported that

COVID-19 pandemic resulted in approximately 1/3 of pregnant women having inadequate antenatal visits and 44.7% of pregnancies with complications due to their fear of contracting infections (1). This study examined the impact of the COVID-19 pandemic on the clinical characteristics of uninfected pregnant women and their neonates by using two ongoing programs conducted by the Maternal and Newborn Health Monitoring Program (MNHMP) and a birth cohort of the Haidian Maternal and Child Care Hospital (HMCCCH) in Beijing, China. The results suggested that the rates of caesarean section (CS) and preterm birth<sup>†</sup> increased slightly in areas that were more affected by the pandemic. NPE were not significantly interrupted, and most maternal and neonatal clinical characteristics were within the normal ranges. The rate of the number of prenatal eligible examinations exceeding 5 times (PEE5) with blood pressure and blood routine examinations during the regulated prenatal care<sup>§</sup> according to the National Standards for Basic Public Health Services in China was significantly reduced in Hubei. We concluded that the frequency of routine prenatal care had been well maintained in China during the pandemic period in 2020. However, special in-time prenatal examination should be provided to improve the quality of care for pregnant women, and screening and management of high-risk pregnancies should be strengthened when pandemic-like circumstances occur in the future.

This prospective cohort study was based on two ongoing multicenter programs including: 1) the MNHMP established in 2013 by the National Center for Women and Children's Health (NCWCH) of China CDC, of which the detailed information had been described previously (2); and 2) a birth cohort in

\* The times of examinations which women took from their first antenatal care examination to childbirth.

† Live infants born before 37 gestational weeks.

§ The regulated prenatal care in standards for the management and service of maternal health is issued in the National Standards for Basic Public Health Services (Third Edition) by National Health Commission in China. There are routine prenatal cares for five times at <13<sup>rd</sup>, 16<sup>th</sup>–20<sup>th</sup>, 21<sup>st</sup>–24<sup>th</sup>, 28<sup>th</sup>–36<sup>th</sup>, and 37<sup>th</sup>–40<sup>th</sup>. The details can be found on the website: <http://www.nhc.gov.cn/>.

HMCCH in Beijing in China. For all areas, pregnant women were recruited with delivery or termination from January 1, 2019 to May 31, 2019 (pre-pandemic period: P-2019) and from January 1, 2020 to May 31, 2020 (pandemic period: P-2020). Finally, 32,277 pregnant women were included from 6 Provincial Administration Level Divisions (PLADs), including 6,449 in Hubei Province, 5,878 in Guangdong Province, 3,641 in Hebei Province, 6,328 in Shandong Province, 2,920 in Yunnan Province, and 7,061 in Beijing Municipality. The main outcomes, including the NPE, PEE5, preterm birth, stillbirth<sup>†</sup>, large for gestational age (LGA)<sup>\*\*</sup>, small for gestational age (SGA)<sup>††</sup>, macrosomia<sup>§§</sup>, and low birth weight (LBW)<sup>¶¶</sup> status were recorded or calculated. Means  $\pm$  standard deviations (SDs) or medians (25%–75% percentile ranges) were used to describe distributions. SGA and LGA status were assessed from gestational week 24–42. COVID-19 pandemic status served as a categorical variable. Three regression models were used to estimate the effects of the pandemic depending on the data distribution, i.e., Poisson, linear, and log-binomial regressions. The confounders included body mass index (BMI, categorical), age (categorical), parity, gravidity, ethnicity, and educational level. The study protocol was approved by the institutional review board of Peking University.

The demographic characteristics of all women were listed in Table 1. The mean ages differed between the two periods (P-2019 *vs.* P-2020) for Hubei (29.1 *vs.* 28.7), Guangdong (28.4 *vs.* 27.9), Beijing (31.6 *vs.* 31.4), and Hebei (29.8 *vs.* 29.4). However, the differences were negligible (maximum 1.7% in Guangdong). Parity distribution varied by location but did not differ between the two periods. The average BMI (kg/m<sup>2</sup>) ranged from 22.2 (Hubei) to 23.2 (Hebei). For Hebei alone, the average BMI increased slightly from 23.1 (P-2019) to 23.5 (P-2020). Educational levels differed greatly; although significant differences between the two periods were evident in Hubei and Guangdong, the overall pattern remained similar.

The maternal and neonatal clinical characteristics

were listed in Table 2. The NPE varied by locations. The average NPE in Hubei and Beijing decreased slightly from P-2019 to P-2020 but increased in Guangdong and Hebei. Comparatively speaking, the ratio of PEE5 significantly decreased from 5.4% (P2019) to 2.6% (P2020) in Hubei. No between-period changes in maternal death, stillbirth, neonatal gender, or normal weight or LBW status were evident. The maternal death and stillbirth rates rarely occurred. Guangdong (28%) and Yunnan (27%) exhibited lower CS rates than the other regions. The CS rates increased significantly between the two periods for Hubei and Guangdong only. Most Apgar scores ranged from 9 to 10 except for Hubei monitored at 1 min, but the differences were negligible. The preterm birth rate increased between the two periods for Hubei and Guangdong only. The macrosomia rate in Beijing only increased by about 2%. The SGA rates decreased for Hubei and Guangdong only. The LGA rate in Hubei only increased from 8% to 10%.

The adjusted regression parameters of the clinical manifestations of the two periods are listed in Table 3, which were consistent with those without adjustment for confounders. For Hubei, the NPE, delivery gestational weeks (DGW)<sup>\*\*\*</sup>, and SGA were negatively associated with the pandemic, and the CS and preterm birth rates were positively associated. Guangdong was similar, but the NPE change lacked significance. The PEE5 in Hubei were negatively associated with the pandemic, while not for others. The effect of the pandemic on preterm birth in Hubei and Guangdong did not change substantially with additional adjustment for CS. In contrast, we only found the positive associations for the macrosomia risk in Beijing and the NPE in Hebei, and a negative association for the DGW in Yunnan.

## DISCUSSION

This study explored the effects of the pandemic on pregnancy-related clinical manifestations in uninfected women. Overall, the effects were minor. However, the significantly increased rates of CS and preterm birth in

<sup>†</sup> Late fetal deaths weighing more than 1,000 g or occurring after 28 weeks gestation.

<sup>\*\*</sup> Live infants born at gestational weeks 24–42 without major birth defects and with birthweight above the 90<sup>th</sup> percentile for gestational age of the reference population mean for birthweight and gestational age.

<sup>††</sup> Live infants born at gestational weeks 24–42 without major birth defects and with birthweight below the 10<sup>th</sup> percentile for gestational age of the reference population mean for birthweight and gestational age.

<sup>§§</sup> Live infants with weight at birth not less than 4,000 g.

<sup>¶¶</sup> Live infants with weight at birth less than 2,500 g.

<sup>\*\*\*</sup> Duration from the last menstrual period reported by the women and the time of delivery.

Hubei and Guangdong with relatively high COVID-19 prevalence level requires attention, as the increased risk of macrosomia in Beijing. Thus, our hypothesis is only partly supported.

Many reports on the pregnancy complications and neonatal birth outcomes of infected women have appeared; the preterm birth and CS rates increased significantly in countries with high COVID-19 burdens (3–4). However, the effects on uninfected pregnant women have been rarely reported. In the United Kingdom, it has been proposed that the stillbirth increase was caused by a reluctance to visit hospitals for fear of contracting COVID-19 (5). The medical facility experienced a major decline in all aspects of routine obstetric activities during pandemic period (6). In China, strict prevention and control policies ensured social distancing. Even in areas with

low infection rates, all nonessential examinations were to be postponed or reduced.

In our study, the NPE decreased only in Hubei by 5%. In the other five areas, the NPE did not decrease and even increased in Hebei. The pandemic did not increase the stillbirth or LBW rates. Beijing (only) exhibited a slightly increased rate of macrosomia. Similar results were found in Wuhan City in Hubei Province suggesting that most of the clinical manifestations did not increase except for the weight of newborns being significantly heavier during the pandemic period (7). All health services worked well, despite the fact that the pandemic consumed a great deal of medical resources. Since the outbreak, medical resources have been rationally allocated using a Joint Prevention and Control Mechanism prepared by the State Council of China to protect pregnant women (8).

TABLE 1. Demographic characteristics of the participants in the 2 periods of 2019 and 2020 in 6 provincial-level administrative divisions (PLADs) of China.

Demographic characteristic	Hubei		Guangdong		Beijing	
	County or district		County or district		County or district	
	Huangmei, Luotian	Huangmei, Luotian	Longchuan, Zijin	Longchuan, Zijin	Haidian	Haidian
Year	P-2019	P-2020	P-2019	P-2020	P-2019	P-2020
No. of subjects	3,300	3,149	3,328	2,550	3,902	3,159
Age (years)	28.7 ± 4.2**	29.1 ± 4.3 <sup>§, §§</sup>	27.9 ± 5.0	28.4 ± 5.0 <sup>§, §§</sup>	31.4 ± 4.0	31.6 ± 4.0 <sup>†, §§</sup>
	28.0 (26.0, 31.0) <sup>††</sup>	29.0 (27.0, 32.0) <sup>§, ¶¶</sup>	27.0 (24.0, 31.0)	28.0 (25.0, 31.0) <sup>§, ¶¶</sup>	31.0 (29.0, 34.0)	31.0 (29.0, 34.0) <sup>†, ¶¶</sup>
Missing	0 (0)	2 (0)	0 (0)	2 (0)	0 (0)	0 (0)
Gravidity						
1 time	1,276 (39)	1,220 (39)	884 (27)	698 (27)	1,785 (46)	1,422 (45)
≥2 times	2,024 (61)	1,929 (61)	2,444 (73)	1,852 (73)	2,117 (54)	1,737 (55)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Parity						
Nulliparous	– <sup>†††</sup>	–	1,255 (38)	960 (38)	2,517 (65)	2,058 (65)
Multiparous	–	–	2,073 (62)	1,590 (62)	1,385 (35)	1,101 (35)
Missing	–	–	0 (0)	0 (0)	0 (0)	0 (0)
BMI (kg/m <sup>2</sup> )	22.2 ± 3.1**	22.3 ± 3.2	22.0 ± 3.3	22.1 ± 3.5	–	–
	21.7 (20.1, 23.8) <sup>††</sup>	21.9 (20, 24)	21.6 (19.6, 24.1)	21.7 (19.5, 24.1)	–	–
Missing	116 (4)	167 (5)	84 (3)	87 (3)	–	–
Education						
Primary or lower	26 (1)	15 (0) <sup>§, ***</sup>	58 (2)	53 (2) <sup>†, ***</sup>	–	–
Junior high	558 (17)	424 (14)	1,865 (56)	1,351 (53)	–	–
Senior high	2,295 (72)	2,377 (78)	760 (23)	566 (22)	–	–
College or higher	316 (10)	242 (8)	645 (19)	580 (23)	–	–
Missing	105 (3)	91 (3)	0 (0)	0 (0)	–	–
Ethnicity						
Han	3,248 (100)	3,086 (100)	3,233 (98)	2,483 (98)	–	–
Others	10 (0)	12 (0)	51 (2)	47 (2)	–	–
Missing	42 (1)	51 (2)	44 (1)	20 (1)	–	–

TABLE 1. (Continued)

Demographic characteristic	Shandong		Hebei		Yunnan	
	Shizhong, Huaiyin		Zhengding, Xingtai		Huaning, Tonghai	
County or district	P-2019	P-2020	P-2019	P-2020	P-2019	P-2020
Year	P-2019	P-2020	P-2019	P-2020	P-2019	P-2020
No. of subjects	3,879	2,449	2,280	1,361	1,952	968
Age (years)	31.3 ± 4.3	31.3 ± 4.2	29.4 ± 3.9	29.8 ± 3.9 <sup>†, §§</sup>	27.9 ± 4.8	28.0 ± 4.6
	31.0 (29.0, 34.0)	31.0 (29.0, 34.0)	29.0 (27.0, 32.0)	30.0 (27.0, 32.0) <sup>†, ¶¶</sup>	28.0 (24.0, 31.0)	28.0 (25.0, 31.0)
Missing	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)
Gravidity						
1 time	1,353 (35)	832 (34)	562 (25)	317 (23)	537 (28)	227 (23) <sup>†, ***</sup>
≥2 times	2,526 (65)	1,617 (66)	1,718 (75)	1,044 (77)	1,415 (72)	741 (77)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Parity						
Nulliparous	1,968 (51)	1,182 (48)	764 (34)	465 (34)	772 (40)	390 (40)
Multiparous	1,911 (49)	1,267 (52)	1,516 (66)	896 (66)	1,180 (60)	578 (60)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
BMI (kg/m <sup>2</sup> )	22.9 ± 3.6	22.8 ± 3.6	23.1 ± 4.0	23.5 ± 4.2	22.1 ± 3.7	22.1 ± 3.8
	22.3 (20.2, 24.8)	22.3 (20.3, 24.6)	22.4 (20.2, 25.3)	22.8 (20.4, 26.1) <sup>†, ¶¶</sup>	21.4 (19.4, 24.1)	21.4 (19.2, 24.2)
Missing	36 (1)	9 (0)	1 (0)	0 (0)	0 (0)	0 (0)
Education						
Primary or lower	9 (0)	9 (0)	19 (1)	4 (0)	199 (10)	86 (9)
Junior high	237 (7)	138 (7)	457 (25)	277 (24)	700 (36)	372 (39)
Senior high	477 (14)	240 (12)	479 (26)	310 (27)	564 (29)	289 (30)
College or higher	2,687 (79)	1,675 (81)	895 (48)	551 (48)	475 (25)	211 (22)
Missing	469 (12)	387 (16)	430 (19)	219 (16)	14 (1)	10 (1)
Ethnicity						
Han	3,740 (98)	2,375 (98)	1,819 (98)	1,124 (99)	1,514 (78)	744 (78)
Others	79 (2)	54 (2)	31 (2)	17 (1)	419 (22)	216 (22)
Missing	60 (2)	20 (1)	430 (19)	220 (16)	19 (1)	8 (1)

Notes: The COVID-19 pandemic level of the 6 PLADs are: Hubei, level IV; Guangdong, level III; Beijing, level II; Shandong, level II; Hebei, level I; and Yunnan, level I.

Abbreviations: P-2019, January 1–May 31, 2019 as the pre-pandemic period; P-2020, January 1–May 31, 2020 as the pandemic period.

\*  $P < 0.05$ ;

†  $P < 0.01$ ;

§  $P < 0.001$ ;

¶ The COVID-19 pandemic levels were classified according to the provincial overall prevalence rate compared to Hubei Province;;

\*\* Mean value ± standard deviation;

†† Median value (25%–75% percentile);

§§ Compared by *t* test;

¶¶ Compared by Mann-Whitney U test;

\*\*\* Compared by Chi-square test;

††† Data was unavailable.

Overall, the pandemic did not compromise routine prenatal examinations in China.

Notably, the CS rate increased in Hubei and Guangdong during the pandemic period. One possible explanation is that the number of high-risk pregnant women with pregnancy complications may increase due to delayed prenatal examinations and in-time interventions during the pandemic. This viewpoint was supported by the decreased PEE5 in Hubei. In India, delayed health-seeking behaviors during pandemic period resulted in 44.7% of pregnancies having

complications, roughly 1/3 of women having an inadequate number of antenatal visits, and a 2.5-fold rise in admission to the intensive care unit of pregnant women (1). Another possible explanation is that the pandemic increased stress and anxiety. In China, a study conducted in 25 hospitals across China during January 1–February 9, 2020 found that the pandemic increased the risk of depressive and anxiety symptoms (9). Perhaps more women requested CS to ensure a live birth. In Wuhan, maternal requested CS significantly increased during the lockdown period (7). For the risk

TABLE 2. Maternal and neonatal clinical characteristics in the two periods of 2019 and 2020 in 6 provincial-level administrative divisions (PLADs) of China.

Characteristic	Hubei		Guangdong		Beijing	
	P-2019	P-2020	P-2019	P-2020	P-2019	P-2020
N1 <sup>¶</sup>	3,300	3,149	3,328	2,550	3,902	3,159
No. of prenatal examinations						
Mean (SD)	5.3 ± 2.5 <sup>**</sup>	5.0 ± 2.0 <sup>§, §§</sup>	5.2 ± 2.5	5.4 ± 2.5 <sup>§, §§</sup>	15.0 ± 2.8	14.0 ± 3.1 <sup>§, §§</sup>
Median (IQR)	5 (4, 6.8) <sup>††</sup>	5 (4, 6) <sup>§, ¶¶</sup>	5 (3, 7)	5 (3, 7) <sup>§, ¶¶</sup>	15 (13, 17)	14 (13, 16) <sup>§, ¶¶</sup>
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Prenatal eligible examinations (> 5 times)						
No	3,123 (94.6)	3,067 (97.4) <sup>§, ***</sup>	3,270 (98.3)	2,494 (97.8)	–	–
Yes	177 (5.4)	82 (2.6)	58 (1.7)	56 (2.2)	–	–
Missing	0 (0)	0 (0)	0 (0)	0 (0)	–	–
Delivery gestational weeks						
Mean±SD	39.0 ± 1.3 <sup>**</sup>	38.9 ± 1.3 <sup>§, §§</sup>	39.2 ± 1.4 <sup>**</sup>	39.0 ± 1.4 <sup>§, §§</sup>	39.11 ± 1.3	39.10 ± 1.4
Median (IQR)	39.0 (38.0, 40.0) <sup>††</sup>	39.0 (38.0, 40.0) <sup>§, ¶¶</sup>	39.3 (38.4, 40.1) <sup>††</sup>	39.1 (38.4, 40.0) <sup>§, ¶¶</sup>	39.3 (38.6, 39.9)	39.1 (38.6, 40.0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Caesarean section (CS)						
No	1,738 (53)	1,449 (46) <sup>§, ***</sup>	2,483 (75)	1,761 (69) <sup>§, ***</sup>	2,273 (58)	1,804 (57)
Yes	1,562 (47)	1,700 (54)	845 (25)	789 (31)	1,629 (42)	1,355 (43)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Maternal death						
No	– <sup>†††</sup>	–	3,328 (100)	2,550 (100)	3,902 (100)	3,159 (100)
Yes	–	–	0 (0)	0 (0)	0 (0)	0 (0)
Missing	–	–	0 (0)	0 (0)	0 (0)	0 (0)
Stillbirth (%)						
No	3,293 (100)	3,143 (100)	3,326 (100)	2,549 (100)	3,900 (100)	3,155 (100)
Yes	7 (0)	6 (0)	2 (0)	1 (0)	2 (0)	4 (0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N2 <sup>¶</sup>	3,293	3,143	3,326	2,549	3,900	3,155
Neonatal gender						
Female	1,548 (47)	1,434 (46)	1,561 (47)	1,192 (47)	1,886 (48)	1,547 (49)
Male	1,745 (53)	1,709 (54)	1,765 (53)	1,356 (53)	2,014 (52)	1,608 (51)
Unknown	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Neonatal weight (kg)						
Mean±SD	3.32 ± 0.4	3.33 ± 0.4	3.16 ± 0.4	3.17 ± 0.4	3.33 ± 0.4	3.32 ± 0.4
Median (IQR)	3.30 (3.00, 3.60)	3.30 (3.00, 3.60)	3.10 (2.90, 3.40)	3.20 (2.90, 3.50)	3.35 (3.08, 3.60)	3.32 (3.08, 3.60)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Apgar score						
1 min (SD)	8.7 ± 0.8	8.9 ± 0.6 <sup>§, §§</sup>	9.4 ± 0.6	9.4 ± 0.6 <sup>*, §§</sup>	10 ± 0.4	9.9 ± 0.5
Missing	454 (14)	586 (19)	0 (0)	0 (0)	2 (0)	2 (0)
5 min (SD)	9.5 ± 0.6	9.4 ± 0.6 <sup>§, §§</sup>	10 ± 0.2	10 ± 0.2	10 ± 0.3	10 ± 0.3
Missing	447 (14)	583 (19)	0 (0)	0 (0)	2 (0)	2 (0)
10 min (SD)	9.5 ± 0.5	9.9 ± 0.4 <sup>§, §§</sup>	10 ± 0.1	10 ± 0.1	10 ± 0.4	10 ± 0.4
Missing	992 (30)	672 (21)	0 (0)	0 (0)	13 (0)	15 (1)
Preterm birth						
No	3,212 (98)	3,036 (97) <sup>†, ***</sup>	3,180 (96)	2,399 (94) <sup>†, ***</sup>	3,729 (96)	3,011 (95)
Yes	81 (2)	107 (3)	146 (4)	150 (6)	171 (4)	144 (5)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Low birth weight						
No	3,235 (98)	3,083 (98)	3,194 (96)	2,434 (96)	3,788 (97)	3,049 (97)
Yes	58 (2)	60 (2)	132 (4)	115 (4)	112 (3)	106 (3)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Macrosomia						
No	3,093 (94)	2,923 (93)	3,239 (97)	2,467 (97)	3,728 (96)	2,977 (94) <sup>†, ***</sup>
Yes	200 (6)	220 (7)	87 (3)	82 (3)	172 (4)	178 (6)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N3 <sup>¶</sup>	3,269	3,118	3,322	2,529	3,857	3,105
Small for gestational age						
No	3,029 (93)	2,929 (94) <sup>†, ***</sup>	2,898 (87)	2,310 (91) <sup>§, ***</sup>	3,688 (96)	2,967 (96)
Yes	240 (7)	189 (6)	424 (13)	219 (9)	169 (4)	138 (4)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Large for gestational age						
No	3,007 (92)	2,817 (90) <sup>†, ***</sup>	3,179 (96)	2,404 (95)	3,531 (919)	2,811 (91)
Yes	262 (8)	301 (10)	143 (4)	125 (5)	326 (9)	294 (9)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

TABLE 2. (Continued)

Characteristic	Shandong		Hebei		Yunnan	
	P-2019	P-2020	P-2019	P-2020	P-2019	P-2020
N1 <sup>¶¶</sup>	3,879	2,449	2,280	1,361	1,952	968
Number of prenatal examinations						
Mean±SD	–	–	5.5 ± 3.0 <sup>**</sup>	6.3 ± 2.8 <sup>§, §§</sup>	11.5 ± 2.6	11.6 ± 2.4
Median (IQR)	–	–	6 (2, 8) <sup>††</sup>	7 (4, 8) <sup>§, ¶¶</sup>	11 (10, 13)	12 (10, 13)
Missing	–	–	0 (0)	0 (0)	0 (0)	0 (0)
Prenatal eligible examinations (>5 times)						
No	–	–	1,606 (70.4)	960 (70.5)	779 (39.9)	249 (25.7) <sup>§, ***</sup>
Yes	–	–	674 (29.6)	401 (29.5)	1,173 (60.1)	719 (74.3)
Missing	–	–	0 (0)	0 (0)	0 (0)	0 (0)
Delivery gestational weeks						
Mean±SD	39.2 ± 1.3	39.2 ± 1.3	39.1 ± 1.4	39.2 ± 1.5	39.0 ± 1.4	38.9 ± 1.4
Median (IQR)	39.3 (38.6, 40.1)	39.3 (38.6, 40.1)	39.3 (38.6, 40.0)	39.3 (38.6, 40.0)	39.0 (38.3, 40.0)	39.0 (38.0, 40.0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Caesarean section						
No	1,947 (50)	1,256 (51)	1,381 (60)	808 (60)	1,439 (74)	693 (72)
Yes	1,932 (50)	1,193 (49)	899 (40)	552 (40)	512 (26)	274 (28)
Missing	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	1 (0)
Maternal death						
No	3,879 (100)	2,449 (100)	2,280 (100)	1,359 (100)	1,748 (100)	909 (100)
Yes	0 (0)	0 (0)	0 (0)	2 (0)	1 (0)	1 (0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	203 (10)	58 (6)
Stillbirth (%)						
No	3,879 (100)	2,449 (100)	2,277 (100)	1,360 (100)	1,946 (100)	965 (100)
Yes	0 (0)	0 (0)	3 (0)	1 (0)	6 (0)	3 (0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
N2 <sup>¶¶</sup>	3879	2449	2277	1360	1946	965
Neonatal gender						
Female	1,889 (49)	1,166 (48)	1,096 (48)	658 (48)	930 (48)	450 (47)
Male	1,988 (51)	1,282 (52)	1,181 (52)	702 (52)	1,016 (52)	515 (53)
Unknown	2 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Neonatal weight (kg)						
Mean±SD	3.40 ± 0.4	3.40 ± 0.4	3.33 ± 0.5	3.32 ± 0.5	3.23 ± 0.5	3.22 ± 0.4
Median (IQR)	3.40 (3.10, 3.70)	3.40 (3.10, 3.70)	3.30 (3.00, 3.60)	3.30 (3.00, 3.60)	3.20 (3.00, 3.50)	3.20 (3.00, 3.50)
Missing	0 (0)	1 (0)	8 (0)	12 (1)	0 (0)	0 (0)
Apgar score						
1 min	–	–	9.9 ± 0.4	9.9 ± 0.4	9.3 ± 1.4	9.5 ± 1 <sup>†, §§</sup>
Missing	–	–	110 (5)	17 (1)	1 (0)	0 (0)
5 min	–	–	10 ± 0.3	10 ± 0.3	9.8 ± 1.2	9.9 ± 0.7 <sup>†, §§</sup>
Missing	–	–	110 (5)	17 (1)	1 (0)	0 (0)
10 min	–	–	10 ± 0.3	10 ± 0.1	9.8 ± 1.2	9.9 ± 0.8 <sup>†, §§</sup>
Missing	–	–	110 (5)	17 (1)	1 (0)	0 (0)
Preterm birth						
No	3,710 (96)	2,359 (96)	2,174 (95)	1,293 (95)	1,845 (95)	929 (96)
Yes	169 (4)	90 (4)	103 (5)	67 (5)	101 (5)	36 (4)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Low birth weight						
No	3,790 (98)	2,397 (98)	2,199 (97)	1,312 (97)	1,863 (96)	934 (97)
Yes	89 (2)	51 (2)	70 (3)	36 (3)	83 (4)	31 (3)
Missing	0 (0)	1 (0)	8 (0)	12 (1)	0 (0)	0 (0)
Macrosomia						
No	3,540 (91)	2,252 (92)	2,117 (93)	1,266 (94)	1,864 (96)	932 (97)
Yes	339 (9)	196 (8)	152 (7)	82 (6)	82 (4)	33 (3)
Missing	0 (0)	1 (0)	8 (0)	12 (1)	0 (0)	0 (0)
N3 <sup>¶¶</sup>	3877	2448	1844	1138	1900	953
Small for gestational age						
No	3,720 (96)	2,351 (96)	1,759 (95)	1,078 (95)	1,717 (90)	875 (92)
Yes	155 (4)	95 (4)	85 (5)	60 (5)	183 (10)	78 (8)
Missing	2 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Large for gestational age						
No	3,358 (87)	2,137 (87)	1,648 (89)	1,038 (91)	1,783 (94)	900 (94)
Yes	517 (13)	309 (13)	196 (11)	100 (9)	117 (6)	53 (6)
Missing	2 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Abbreviations: P-2019, January 1–May 31, 2019 as the pre-pandemic period; P-2020, January 1–May 31, 2020 as the pandemic period.

\*  $P < 0.05$ ;†  $P < 0.01$ ;§  $P < 0.001$ ;

¶ N1: number of the total subjects, N2: those N1 without delivering stillbirths; and N3: those N2 delivering fetuses at gestational weeks 24–42 and without major birth defects;

\*\* Mean value ± standard deviation (SD);

†† Median value (25%–75% percentile);

§§ Compared by *t* test;

¶¶ Compared by Mann-Whitney U test;

\*\*\* Compared by Chi-square test;

††† Data are unavailable.

TABLE 3. Adjusted relative risk associated with the occurrence of the COVID-19 between 2019 and 2020 in 6 provincial-level administrative divisions (PLADs) of China.

Characteristics	Hubei	Guangdong	Beijing
NPE <sup>¶, §§</sup>	0.95 (0.92, 0.99) <sup>†</sup>	1.03 (1.00, 1.07)	0.99 (0.96, 1.02)
PEE5 <sup>** , §§</sup>	0.49 (0.37, 0.64) <sup>§</sup>	1.22 (0.84, 1.76)	–
DGW <sup>††, §§</sup>	–0.15 (–0.22, –0.08) <sup>§</sup>	–0.16 (–0.23, –0.08) <sup>§</sup>	0 (–0.02, 0.02)
CS <sup>** , §§</sup>	1.11 (1.06, 1.17) <sup>§</sup>	1.17 (1.08, 1.27) <sup>§</sup>	1.02 (0.97, 1.08)
NW <sup>††, §§</sup>	0 (–0.02, 0.02)	0.01 (–0.01, 0.03)	–0.01 (–0.07, 0.05)
Stillbirth <sup>** , §§</sup>	0.88 (0.30, 2.63)	1.5 (0.09, 24.47)	2.43 (0.44, 13.28)
Preterm birth <sup>** , §§</sup>	1.37 (1.02, 1.84) <sup>*</sup>	1.34 (1.07, 1.67) <sup>*</sup>	1.03 (0.83, 1.28)
LBW <sup>** , §§</sup>	1.08 (0.75, 1.58)	1.18 (0.92, 1.51)	1.16 (0.89, 1.50)
Macrosomia <sup>** , §§</sup>	1.10 (0.91, 1.34)	1.18 (0.87, 1.59)	1.26 (1.03, 1.55) <sup>*</sup>
SGA <sup>** , §§</sup>	0.81 (0.67, 0.98) <sup>*</sup>	0.71 (0.60, 0.83) <sup>§</sup>	1.01 (0.81, 1.25)
LGA <sup>** , §§</sup>	1.17 (0.99, 1.38)	1.10 (0.87, 1.39)	1.11 (0.96, 1.29)

  

Characteristics	Shandong	Hebei	Yunnan
NPE <sup>¶, §§</sup>	–	1.08 (1.03, 1.13) <sup>§</sup>	1.0 (0.96, 1.05)
PEE5 <sup>** , §§</sup>	–	0.96 (0.82, 1.12)	1.97 (1.65, 2.34) <sup>§</sup>
DGW <sup>††, §§</sup>	–0.02 (–0.09, 0.05)	0 (–0.11, 0.1)	–0.13 (–0.23, –0.02) <sup>*</sup>
CS <sup>** , §§</sup>	0.99 (0.94, 1.04)	0.99 (0.92, 1.07)	1.05 (0.93, 1.19)
NW <sup>††, §§</sup>	–0.01 (–0.03, 0.02)	–0.02 (–0.06, 0.01)	–0.01 (–0.04, 0.03)
Stillbirth <sup>** , §§</sup>	–	0.58 (0.06, 5.55)	0.66 (0.13, 3.31)
Preterm birth <sup>** , §§</sup>	0.85 (0.64, 1.11)	1.01 (0.72, 1.42)	0.73 (0.50, 1.06)
LBW <sup>** , §§</sup>	0.98 (0.67, 1.43)	0.75 (0.48, 1.18)	0.77 (0.51, 1.16)
Macrosomia <sup>** , §§</sup>	0.88 (0.73, 1.06)	0.86 (0.65, 1.14)	0.83 (0.56, 1.24)
SGA <sup>** , §§</sup>	0.98 (0.74, 1.30)	1.13 (0.82, 1.55)	0.87 (0.67, 1.12)
LGA <sup>** , §§</sup>	0.93 (0.81, 1.08)	0.82 (0.65, 1.03)	0.87 (0.63, 1.19)

Abbreviations: NPE, No. of prenatal examinations; PEE5, Prenatal eligible examinations of  $\geq 5$  times; DGW, delivery gestational weeks; CS, Caesarean section; NW, Neonatal weight; LBW, low birth weight; SGA, small for gestational age; LGA, large for gestational age.

<sup>\*</sup>  $P < 0.05$ ;

<sup>†</sup>  $P < 0.01$ ;

<sup>§</sup>  $P < 0.001$ ;

<sup>¶</sup> Relative risk calculated by Poisson regression model;

<sup>\*\*</sup> Relative risk calculated by log-binomial regression model;

<sup>††</sup> Regression coefficient ( $\beta$  value) calculated by linear regression model;

<sup>§§</sup> Adjusted for BMI (categorical), age (categorical), parity, gravidity, ethnicity, and education. For Hubei Province, parity information is unavailable. For Beijing, the information of BMI, ethnicity, and education is unavailable.

of preterm birth in Hubei and Guangdong, it increased regardless of their higher CS rates. According to clinical practices, women with preterm birth usually had certain pregnancy complications. Though, the routine NPE had been maintained during the pandemic period in China, the prenatal care quality could not be ensured. It is speculated that certain pregnancy complications, drug misuse, or abnormal syndromes may not be treated as usual, which can trigger preterm birth. Therefore, special in-time prenatal examinations should be provided to improve prenatal care quality with certain pregnancy complications when a pandemic occurs in future.

The results of this study were subject to some limitations. First, this study only included 11 county-level study settings in 6 PLADs to represent a nationwide survey. Second, the asymptomatic infection cases were not excluded by the RNA test. However, we employed a population-based monitoring system by HMCCH with high-quality data. Also, the prevalence rate of asymptomatic infections in China had been at a very low level to  $10^{-6}$ – $10^{-4}$  (10), which does not affect our statistical results for the non-infected pregnant women. In summary, prenatal examinations proceeded as normal and most maternal and neonatal clinical characteristics were within normal ranges. It should be

noted that the prenatal care quality may be reduced due to limitations in medical resources. Only specific interventions were additionally required to protect pregnant women with pregnancy complications living in regions with a high burden of COVID-19 pandemic.

Psychological counseling and transfer treatment channel should be strengthened for those at high risk during lockdown. For example, online psychological counseling can be used as a good auxiliary method during severe pandemic conditions.

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