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Supplementary appendix 2

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**Preterm births in China between 2012 and 2018: an observational study
of more than 9 million women**

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Appendix 1: Sampling, data quality control strategies, and statistical analysis

Sampling

China's National Maternal Near Miss Surveillance System (NMNMSS) is a facility-based surveillance system established in October 2010. The sample framework of the NMNMSS has been previously described in detail.¹⁻³ Urban districts and rural counties were based on China's National Maternal and Child Mortality Surveillance System (NMCMS). The NMCMS, a well-established population-based maternal and child death registry system, was established by the Ministry of Health of China in 1996. The NMCMS included 176 urban districts and rural counties in 1996 using stratified random sampling based on 17 socioeconomic strata across China.⁴ With the decline in maternal and child mortality rates in recent years in China, 30 urban districts and 130 rural counties were added to the NMCMS to increase the sample size for national representation. Thus, the NMCMS covered 127 urban districts and 209 rural counties. In 2010, the NMNMSS included 326 urban districts and rural counties. Among these, 273 urban districts and rural counties were selected from the NMCMS by region strata and urban or rural characteristics. The additional 53 urban districts and rural counties that were part of the provincial Maternal and Child Mortality Surveillance System were sampled randomly within the strata to ensure proportional representation of urban and rural populations across all three regions (eastern, central, and western) in China. A map of the surveillance sites in the NMNMSS has been published in another study.³ Last, according to the health facility selection criteria of WHO Global Survey for monitoring maternal and perinatal health,⁵ once the surveillance sites were selected, two health facilities in these areas with more than 1,000 deliveries per year were randomly selected (or one facility if only one was available).

Data quality control strategies

For each hospital, an associated director in the obstetric department supervised implementation of the surveillance program and ensured the completeness, accuracy, and timeliness of the data using random samples of the data-collection forms. Incomplete forms and incorrect records required immediate correction. The data could also be monitored on the online reporting system. Furthermore, four levels of quality assurance were routinely implemented to verify the quality of the records. Data quality assurance was conducted for all hospitals at the county level (twice a year) and at the municipal and provincial levels (once a year) by staff from maternal and child health care hospitals at each level. Finally, national data quality assurance was conducted by the National Office for Maternal and Child Health Surveillance through visits to six to eight randomly selected hospitals in each province once a year. All quality-control results were entered into the online reporting system, and surveillance hospitals were asked to re-examine data when errors exceeded a predefined standard (e.g., pregnancy complications if underreported by more than 5%, maternal deaths if underreported by more than 1%, and maternal near misses if underreported by more than 5%). The latest quality-control results in the online reporting system showed the individual form error rate was less than 1% at all levels.

Statistical analysis

We analyzed changes in the overall and subgroup rates of preterm birth and the proportions of maternal sociodemographic and obstetric characteristics associated with preterm birth (maternal age, antenatal visits, multiple pregnancies, caesarean section, and obstetric complications) between 2012 and 2018. We first described time trends in the proportion of these factors among all pregnancies during the study period. As we supposed antenatal visits and caesarean section to be potentially modifiable factors for preterm birth, we first selected

singleton pregnancies to examine the protective effect of antenatal visits on preterm birth, considering multiple pregnancy to be a risk factor.⁶ Due to the small numbers, women with 0-3 antenatal visits were combined into one group. We displayed time trends in the overall and subgroup rates of preterm birth and concurrent changes in the proportions of maternal factors stratified by the number of antenatal visits (0-3, 4-6, ≥ 7). Due to a possible association between caesarean section and advanced maternal age and multiple pregnancy,⁷⁻⁹ we further selected singleton pregnancies with mothers aged 25-29 years to assess the effect of the reduction in caesarean section rates on preterm birth. We displayed time trends in the overall and subgroup rates of preterm birth and concurrent trends in the caesarean section rates among women with obstetric complications.

References

1. Mu Y, Wang X, Li X, et al. The national maternal near miss surveillance in China: A facility-based surveillance system covered 30 provinces. *Medicine* 2019; **98**(44): e17679.
2. Zhu J, Liang J, Mu Y, et al. Sociodemographic and obstetric characteristics of stillbirths in China: a census of nearly 4 million health facility births between 2012 and 2014. *The Lancet Global health* 2016; **4**(2): e109-18.
3. Liang J, Mu Y, Li X, et al. Relaxation of the one child policy and trends in caesarean section rates and birth outcomes in China between 2012 and 2016: observational study of nearly seven million health facility births. *Bmj* 2018; **360**: k817.
4. Feng XL, Guo S, Hipgrave D, et al. China's facility-based birth strategy and neonatal mortality: a population-based epidemiological study. *Lancet* 2011; **378**(9801): 1493-500.
5. Shah A, Faundes A, Machoki M, et al. Methodological considerations in implementing the WHO Global Survey for Monitoring Maternal and Perinatal Health. *Bulletin of the World Health Organization* 2008; **86**(2): 126-31.

6. Goldenberg RL, Culhane JF, Iams JD, Romero R. Epidemiology and causes of preterm birth. *Lancet* 2008; **371**(9606): 75-84.
7. Harrison MS, Garces AL, Goudar SS, et al. Cesarean birth in the Global Network for Women's and Children's Health Research: trends in utilization, risk factors, and subgroups with high cesarean birth rates. *Reproductive health* 2020; **17**(Suppl 3): 165.
8. Patel RR, Peters TJ, Murphy DJ. Prenatal risk factors for Caesarean section. Analyses of the ALSPAC cohort of 12,944 women in England. *International journal of epidemiology* 2005; **34**(2): 353-67.
9. Garen IF, Morgenstern H, Greenland S, Gifford DS. Explaining the association of maternal age with Cesarean delivery for nulliparous and parous women. *Journal of clinical epidemiology* 2003; **56**(11): 1100-10.

Table S1: Characteristics of hospital levels 1-3 in China

Criteria*	Hospital level 1	Hospital level 2	Hospital level 3
Number of beds	20-99	100-499	≥500
Categories of clinical departments	Including at least: emergency department, internal medicine department, surgery department, gynecology department, health care department	Including at least: emergency department, internal medicine department, surgery department, gynecology department, pediatrics department, ophthalmology department, ear-nose-throat department, stomatology department, dermatological department, anesthesiology department, infectious diseases department, health care department	Including at least: emergency department, internal medicine department, surgery department, gynecology department, pediatrics department, ophthalmology department, ear-nose-throat department, stomatology department, dermatological department, anesthesiology department, infectious diseases department, traditional Chinese medicine department, rehabilitation department, health care department
Number of medical personnel	At least 0.7 medical staff per bed; At least one attending doctor	At least 0.88 medical staff per bed; At least 0.4 nurses per bed; At least 3 deputy chief physicians; At least one attending doctor in each clinical department	At least 1.03 medical staff per bed; At least 0.4 nurses per bed; At least one deputy chief physician in each clinical department; At least 2 clinical nutritionists; The proportion of engineering and technical personnel (technicians, assistant engineers and above) in the total number of health technical personnel shall not be less than 1%
Size of every room	Floor area per bed: ≥45m ²	Floor area per bed: ≥45m ² ; Net use area per bed in ward: ≥5m ² ; The daily average number of outpatients accounts for the floor area of the outpatient clinic: ≥3m ²	Floor area per bed: ≥45m ² ; Net use area per bed in ward: ≥6m ² ; The daily average number of outpatients accounts for the floor area of the outpatient clinic: ≥4m ²
Type and quantity of equipment	Basic equipment, including: electrocardiograph, breathing balloon, and other equipment related to diagnosis and treatment	Basic equipment, including: electrocardiograph, breathing balloon, ventilator, automatic gastric lavage machine, cardiac defibrillator, baby incubator slit lamp, dental treatment chair, multi-functional rescue bed, gastroscopy, and other equipment related to diagnosis and treatment	Basic equipment, including: electrocardiograph, breathing balloon, ventilator, automatic gastric lavage machine, cardiac defibrillator, baby incubator slit lamp, dental treatment chair, multi-functional rescue bed, gastroscopy, bronchoscope, esophagoscope, high frequency electric knife, electroencephalograph, hemodialyzer, and other equipment related to diagnosis and treatment

*According to the measures for the administration of the hospital grade by Ministry of Health of China.

Ref: Ministry of Health of China. The measures for the administration of the hospital grade. 1989.

<https://baike.baidu.com/item/%E5%8C%BB%E9%99%A2%E5%88%86%E7%BA%A7%E7%AE%A1%E7%90%86%E5%8A%9E%E6%B3%95/420525?fr=aladdin>. (in Chinese)

Table S2: Definitions of all variables in this analysis

Variables	Definition	Categories
Preterm birth	A delivery before 37 completed weeks of gestation according to the WHO criteria	Very preterm=28-31 weeks Moderate preterm=32-33 weeks Late preterm=34-36 weeks
Region	Chinese geographical division based on sociodemographic status according to China's criteria	Eastern, central, western
Hospital level	The capability in providing health care and medical service according to China's criteria	Level 1, level 2, level 3
Maternal education	Number of years completed at school	Illiterate=none, primary school=1-6 years, middle school=7-9 years, high school=10-12 years, college or higher= \geq 13 years
Marital status	Mothers' marital status	Married, single/widowed/divorced
Maternal age	Age of mothers at delivery	<20, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 years
Antenatal visits	Frequency of medical examination and health care in hospitals during pregnancy according to China's criteria	0, 1-3, 4-6, 7-9, \geq 10
Parity	Number of live births and stillbirths born before the current pregnancy	Primiparous, multiparous
Type of pregnancy	Number of fetuses	Singleton, multiple
Mode of delivery	The mode that a fetus is delivered from the uterus	Vaginal, caesarean
Maternal complications	Diseases occurring during pregnancy and childbirth or medical diseases before pregnancy	Antepartum complications, medical disease, none of the above

Table S3: The variance inflation factor (VIF) of the independent variables of the model

Variable	VIF	
	Model I	Model II
Region		
East	1.30	1.30
West	1.26	1.26
Maternal education		
Illiterate	1.02	1.02
Primary school	1.08	1.08
High school	1.41	1.41
College or higher	1.78	1.78
Marital status	1.08	1.08
Maternal age (years)		
<20	1.16	1.16
20-24	1.27	1.27
30-34	1.26	1.27
35-39	1.20	1.20
40-44	1.05	1.06
45-49	1.00	1.00
Antenatal visits		
None	1.03	1.03
1-3	1.15	1.15
7-9	1.47	1.47
≥10	1.69	1.70
Parity	1.33	1.34
Type of pregnancy	1.00	1.01
Maternal complications		
Antepartum complications	..	1.04
Medical diseases	..	1.04
Mean VIF	1.24	1.22

Table S4: Models testing for goodness of fit

Variable	AIC
Region	4231738.4
Region + Maternal education	4121661.1
Region + Maternal education + Marital status	4119660.6
Region + Maternal education + Marital status + Maternal age	3940398.2
Region + Maternal education + Marital status + Maternal age + Antenatal visits	3777196.6
Region + Maternal education + Marital status + Maternal age + Antenatal visits + Parity	3775393.9
Region + Maternal education + Marital status + Maternal age + Antenatal visits + Parity + Type of pregnancy	3583228.3
Region + Maternal education + Marital status + Maternal age + Antenatal visits + Parity + Type of pregnancy + Maternal complications	3414773.1

AIC= Akaike's information criterion.

Table S5: Changes in maternal age, antenatal visits, multiple pregnancies, and obstetric factors associated with preterm birth in primiparous and multiparous women in China, 2012-18

	Year							Change 2012-2018	p value for trend
	2012	2013	2014	2015	2016	2017	2018		
All pregnancies (n=9645646)									
Maternal age (years)									
< 20	3.1%	3.3%	2.9%	3.1%	2.3%	1.5%	1.3%	-58.0	<0.0001
20-24	26.7%	25.5%	21.9%	20.4%	16.6%	12.8%	12.3%	-53.7	<0.0001
25-29	39.3%	39.9%	42.7%	41.5%	44.5%	38.7%	38.5%	-2.1	<0.0001
30-34	19.1%	20.0%	20.6%	21.5%	23.7%	28.5%	30.8%	61.5	<0.0001
≥ 35	7.4%	8.2%	8.2%	10.0%	10.6%	16.7%	15.9%	113.9	<0.0001
Antenatal visits									
0-3	11.9%	10.8%	8.9%	8.3%	6.4%	5.1%	4.3%	-63.6	<0.0001
4-6	35.7%	33.9%	31.5%	30.8%	28.4%	23.7%	21.2%	-40.5	<0.0001
≥7	50.2%	52.7%	56.8%	58.4%	62.5%	68.4%	70.7%	40.8	<0.0001
Type of pregnancy									
Singleton	98.4%	98.3%	98.3%	98.2%	98.3%	98.2%	98.1%	-0.3	<0.0001
Multiple	1.6%	1.7%	1.8%	1.9%	1.7%	1.8%	1.9%	17.8	<0.0001
Mode of delivery									
Vaginal	52.5%	52.1%	54.4%	56.2%	57.7%	55.7%	55.0%	4.9	<0.0001
Caesarean	47.5%	47.9%	45.6%	43.8%	42.3%	44.3%	45.0%	-5.3	<0.0001
Maternal complications									
Antepartum complications	14.4%	17.1%	18.5%	20.0%	20.9%	22.3%	23.8%	65.5	<0.0001

Medical diseases	3.5%	4.7%	5.8%	7.0%	7.9%	9.5%	11.2%	223.9	<0.0001
None of the above	82.1%	78.2%	75.7%	73.0%	71.2%	68.1%	65.0%	-20.9	<0.0001
Primiparous women (n= 5440535)*									
Maternal age (years)									
< 20	4.3%	4.7%	4.2%	4.8%	3.7%	2.7%	2.3%	-46.3	<0.0001
20-24	32.6%	31.3%	27.2%	26.7%	22.4%	19.2%	18.1%	-44.6	<0.0001
25-29	42.2%	43.1%	47.1%	46.2%	52.3%	49.3%	48.7%	15.5	<0.0001
30-34	14.2%	15.1%	15.0%	15.1%	16.0%	21.8%	24.2%	71.2	<0.0001
≥ 35	2.8%	3.1%	3.1%	3.7%	3.4%	5.4%	5.5%	100.7	<0.0001
Antenatal visits									
0-3	8.8%	7.8%	6.4%	6.0%	4.7%	3.8%	3.3%	-62.4	<0.0001
4-6	31.5%	29.5%	26.9%	26.5%	24.0%	19.4%	17.3%	-45.1	<0.0001
≥7	57.6%	60.1%	63.9%	64.9%	68.5%	74.0%	76.0%	32.0	<0.0001
Type of pregnancy									
Singleton	98.4%	98.2%	98.1%	97.9%	98.0%	97.8%	97.5%	-0.8	<0.0001
Multiple	1.6%	1.8%	1.9%	2.1%	2.0%	2.3%	2.5%	50.3	<0.0001
Mode of delivery									
Vaginal	51.4%	51.4%	55.3%	58.3%	61.3%	60.3%	59.1%	15.0	<0.0001
Caesarean	48.6%	48.6%	44.7%	41.7%	38.6%	39.7%	40.9%	-15.8	<0.0001
Maternal complications									
Antepartum complications	15.3%	18.2%	20.0%	22.1%	23.4%	25.6%	27.4%	79.4	<0.0001
Medical diseases	3.7%	5.0%	6.1%	7.2%	7.9%	9.3%	10.9%	196.2	<0.0001
None of the above	81.1%	76.9%	73.9%	70.8%	68.8%	65.2%	61.7%	-23.9	<0.0001
Multiparous women (n= 4194100)*									

Maternal age (years)									
< 20	0.8%	0.9%	0.9%	1.0%	0.8%	0.4%	0.4%	-51.3	<0.0001
20-24	14.9%	15.1%	13.4%	12.3%	9.9%	7.1%	7.0%	-53.2	<0.0001
25-29	33.9%	34.1%	35.6%	35.3%	35.6%	29.2%	28.9%	-14.5	<0.0001
30-34	28.6%	28.8%	29.5%	29.7%	32.5%	34.6%	36.9%	28.9	<0.0001
≥ 35	16.5%	17.3%	16.4%	18.0%	18.9%	26.8%	25.5%	54.5	<0.0001
Antenatal visits									
0-3	18.1%	16.1%	12.9%	11.2%	8.4%	6.2%	5.4%	-70.3	<0.0001
4-6	43.9%	41.6%	38.8%	36.3%	33.4%	27.5%	25.1%	-42.7	<0.0001
≥7	35.9%	39.5%	45.4%	50.0%	55.5%	63.5%	66.3%	84.9	<0.0001
Type of pregnancy									
Singleton	98.4%	98.4%	98.4%	98.5%	98.6%	98.7%	98.6%	0.2	<0.0001
Multiple	1.6%	1.6%	1.6%	1.5%	1.4%	1.3%	1.4%	-15.2	<0.0001
Mode of delivery									
Vaginal	54.4%	53.4%	53.1%	53.4%	53.4%	51.5%	50.9%	-6.4	<0.0001
Caesarean	45.6%	46.6%	46.9%	46.5%	46.5%	48.5%	49.1%	7.7	<0.0001
Maternal complications									
Antepartum complications	12.7%	15.2%	16.1%	17.3%	18.1%	19.4%	20.4%	61.2	<0.0001
Medical diseases	3.0%	4.3%	5.5%	6.9%	7.9%	9.8%	11.5%	278.6	<0.0001
None of the above	84.3%	80.5%	78.4%	75.9%	74.0%	70.9%	68.1%	-19.2	<0.0001

Data are percentages of the total number of all pregnancies unless otherwise stated.

*A total of 11,011 (0.1%) women did not report information on parity.

Table S6: Changes in preterm birth rate, advanced maternal age (≥ 35 years), and obstetric factors associated with preterm births according to frequency of antenatal visits in singleton pregnancies in China, 2012-18

Antenatal visits	Characteristics	Year							Change 2012-2018	p value for trend
		2012	2013	2014	2015	2016	2017	2018		
0-3	No. of deliveries	151763	134120	126269	103589	93691	75392	58160	-61.7	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	1.2%	1.3%	1.3%	1.4%	1.5%	1.5%	1.5%	26.9	<0.0001
	Moderate preterm	1.3%	1.4%	1.4%	1.5%	1.5%	1.5%	1.5%	15.4	<0.0001
	Late preterm	5.4%	5.7%	5.8%	5.9%	6.2%	6.2%	6.1%	12.0	<0.0001
	All preterm	7.9%	8.4%	8.4%	8.8%	9.1%	9.2%	9.1%	14.7	<0.0001
	Maternal age ≥ 35 years	9.3%	9.9%	9.5%	10.7%	11.1%	15.3%	15.0%	61.4	<0.0001
	Caesarean	39.0%	39.9%	38.7%	36.8%	35.9%	37.6%	38.1%	-2.2	<0.0001
	Antepartum complications	14.2%	17.5%	19.2%	20.2%	20.7%	21.5%	22.5%	57.8	<0.0001
Medical diseases	2.1%	2.9%	3.6%	4.4%	5.7%	6.4%	8.1%	280.7	<0.0001	
4-6	No. of deliveries	454047	420893	447625	386557	416174	352951	284888	-37.3	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	0.5%	0.5%	0.6%	0.7%	0.7%	0.7%	0.8%	54.9	<0.0001
	Moderate preterm	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.9%	20.8	<0.0001
	Late preterm	4.2%	4.1%	4.1%	4.4%	4.6%	4.7%	4.9%	16.4	<0.0001
	All preterm	5.4%	5.3%	5.5%	5.8%	6.1%	6.3%	6.6%	20.6	<0.0001
	Maternal age ≥ 35 years	7.4%	7.9%	7.8%	8.9%	9.4%	13.9%	13.4%	82.1	<0.0001
	Caesarean	44.4%	44.8%	43.4%	41.5%	40.2%	41.5%	42.0%	-5.4	<0.0001
	Antepartum complications	12.1%	14.7%	16.0%	17.3%	18.3%	19.3%	20.9%	72.5	<0.0001
Medical diseases	2.2%	2.7%	3.3%	4.2%	4.9%	5.8%	7.0%	223.3	<0.0001	

≥ 7	No. of deliveries	637869	652256	803990	731077	914444	1016940	946090	48.3	..	
	Preterm birth rate (per 100 deliveries)[†]										
	Very preterm	0.3%	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	14.7	<0.0001
	Moderate preterm	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	10.4	0.0006
	Late preterm	3.5%	3.5%	3.5%	3.5%	3.6%	3.7%	3.8%	3.8%	10.1	<0.0001
	All preterm	4.3%	4.3%	4.3%	4.4%	4.5%	4.6%	4.7%	4.7%	10.3	<0.0001
	Maternal age ≥ 35 years	6.9%	7.9%	8.0%	10.2%	11.0%	17.5%	16.4%	16.4%	138.5	<0.0001
	Caesarean	50.5%	50.2%	46.4%	44.4%	42.4%	44.3%	44.8%	44.8%	-11.3	<0.0001
	Antepartum complications	14.9%	17.4%	18.7%	20.2%	20.9%	22.2%	23.5%	23.5%	57.1	<0.0001
Medical diseases	4.6%	6.3%	7.4%	8.8%	9.4%	11.0%	12.7%	12.7%	175.0	<0.0001	

Data are percentages of the total number of deliveries unless otherwise stated. Very preterm babies were born after 28–31 completed weeks gestation. Moderate preterm babies were born after 32–33 weeks gestation. Late preterm babies were born after 34–36 weeks gestation.

[†]Adjusted for the sampling distribution of the population.

Table S7: Changes in preterm birth rate, advanced maternal age (≥ 35 years), and obstetric factors associated with preterm births according to frequency of antenatal visits in singleton primiparous pregnancies in China, 2012-18

Antenatal visits	Characteristics	Year							Change 2012-2018	p value for trend
		2012	2013	2014	2015	2016	2017	2018		
0-3	No. of deliveries	73644	62117	55737	42342	36437	26607	21132	-71.3	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	1.2%	1.4%	1.2%	1.4%	1.4%	1.6%	1.5%	26.5	<0.0001
	Moderate preterm	1.3%	1.4%	1.4%	1.6%	1.5%	1.5%	1.4%	11.6	0.0008
	Late preterm	5.6%	5.7%	5.9%	6.1%	6.4%	6.2%	6.2%	10.4	<0.0001
	All preterm	8.0%	8.5%	8.5%	9.2%	9.3%	9.3%	9.1%	13.1	<0.0001
	Maternal age ≥ 35 years	2.0%	2.3%	2.3%	2.7%	2.9%	3.9%	4.1%	102.0	<0.0001
	Caesarean	39.7%	40.4%	38.5%	35.2%	33.5%	34.4%	35.5%	-10.7	<0.0001
	Antepartum complications	14.8%	18.4%	20.8%	22.2%	22.7%	23.5%	24.7%	66.7	<0.0001
Medical diseases	2.0%	2.8%	3.5%	4.4%	5.8%	6.3%	7.8%	284.7	<0.0001	
4-6	No. of deliveries	264477	235058	235035	187150	187541	136593	111163	-58.0	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	0.5%	0.5%	0.6%	0.7%	0.7%	0.8%	0.8%	69.4	<0.0001
	Moderate preterm	0.7%	0.8%	0.7%	0.8%	0.8%	0.9%	0.9%	22.2	<0.0001
	Late preterm	4.3%	4.1%	4.2%	4.4%	4.7%	4.8%	5.0%	16.3	<0.0001
	All preterm	5.5%	5.4%	5.5%	5.9%	6.2%	6.4%	6.7%	21.8	<0.0001
	Maternal age ≥ 35 years	1.9%	2.1%	2.1%	2.5%	2.3%	3.5%	3.7%	89.2	<0.0001
	Caesarean	45.3%	45.8%	43.1%	40.0%	37.1%	37.7%	38.4%	-15.3	<0.0001
	Antepartum complications	12.9%	15.9%	17.7%	19.6%	21.0%	22.5%	24.6%	90.3	<0.0001
Medical diseases	2.1%	2.7%	3.3%	4.1%	4.8%	5.7%	7.0%	232.2	<0.0001	

≥ 7	No. of deliveries	482614	476616	556104	456932	534808	518339	488340	1.2	..	
	Preterm birth rate (per 100 deliveries)[†]										
	Very preterm	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	20.0	<0.0001	
	Moderate preterm	0.4%	0.5%	0.4%	0.4%	0.4%	0.5%	0.5%	9.1	<0.0001	
	Late preterm	3.3%	3.3%	3.3%	3.4%	3.4%	3.5%	3.6%	6.9	<0.0001	
	All preterm	4.1%	4.0%	4.0%	4.1%	4.2%	4.3%	4.4%	8.2	<0.0001	
	Maternal age ≥ 35 years	3.2%	3.6%	3.5%	4.1%	3.7%	5.7%	5.8%	81.2	<0.0001	
	Caesarean	50.6%	49.9%	44.6%	41.2%	37.8%	38.6%	39.7%	-21.5	<0.0001	
	Antepartum complications	15.6%	18.2%	19.9%	21.9%	23.1%	25.3%	26.7%	71.0	<0.0001	
Medical diseases	4.7%	6.3%	7.4%	8.5%	9.0%	10.3%	11.9%	153.0	<0.0001		

Data are percentages of the total number of deliveries unless otherwise stated. Very preterm babies were born after 28–31 completed weeks gestation. Moderate preterm babies were born after 32–33 weeks gestation. Late preterm babies were born after 34–36 weeks gestation.

[†]Adjusted for the sampling distribution of the population.

Table S8: Changes in preterm birth rate, advanced maternal age (≥ 35 years), and obstetric factors associated with preterm births according to frequency of antenatal visits in singleton multiparous pregnancies in China, 2012-18

Antenatal visits	Characteristics	Year							Change 2012-2018	p value for trend
		2012	2013	2014	2015	2016	2017	2018		
0-3	No. of deliveries	78030	71966	70486	61206	57216	48748	37008	-52.6	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	1.2%	1.3%	1.3%	1.4%	1.5%	1.5%	1.5%	26.7	<0.0001
	Moderate preterm	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.5%	17.7	<0.0001
	Late preterm	5.3%	5.7%	5.7%	5.8%	6.1%	6.2%	6.0%	14.1	<0.0001
	All preterm	7.8%	8.3%	8.4%	8.6%	9.0%	9.1%	9.1%	16.6	<0.0001
	Maternal age ≥ 35 years	16.2%	16.4%	15.2%	16.2%	16.3%	21.6%	21.2%	31.4	<0.0001
	Caesarean	38.3%	39.4%	38.9%	37.9%	37.5%	39.3%	39.6%	3.5	0.14
	Antepartum complications	13.7%	16.8%	18.0%	18.8%	19.5%	20.5%	21.2%	54.9	<0.0001
Medical diseases	2.2%	3.1%	3.6%	4.5%	5.5%	6.5%	8.2%	274.1	<0.0001	
4-6	No. of deliveries	189270	185810	212570	199393	228620	216344	173711	-8.2	..
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	0.5%	0.6%	0.6%	0.6%	0.7%	0.7%	0.8%	40.7	<0.0001
	Moderate preterm	0.7%	0.7%	0.7%	0.8%	0.8%	0.8%	0.9%	21.1	<0.0001
	Late preterm	4.1%	4.0%	4.1%	4.3%	4.6%	4.7%	4.9%	18.0	<0.0001
	All preterm	5.4%	5.3%	5.5%	5.7%	6.1%	6.2%	6.5%	20.9	<0.0001
	Maternal age ≥ 35 years	14.9%	15.2%	14.2%	15.0%	15.1%	20.5%	19.6%	31.4	<0.0001
	Caesarean	43.2%	43.5%	43.6%	42.9%	42.7%	43.9%	44.3%	2.6	<0.0001
	Antepartum complications	10.9%	13.2%	14.1%	15.1%	16.0%	17.2%	18.5%	69.0	<0.0001
Medical diseases	2.2%	2.7%	3.4%	4.2%	5.0%	5.8%	6.9%	213.1	<0.0001	

≥ 7	No. of deliveries	154384	175599	247808	274071	379585	498547	457645	196.4	..	
	Preterm birth rate (per 100 deliveries)[†]										
	Very preterm	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	-8.9	0.02
	Moderate preterm	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.6%	0.6%	-3.3	0.0019
	Late preterm	3.9%	3.9%	3.9%	3.8%	3.9%	3.9%	4.1%	4.1%	4.6	0.0088
	All preterm	4.9%	5.0%	4.9%	4.8%	4.8%	4.8%	5.1%	5.1%	2.4	0.33
	Maternal age ≥ 35 years	18.5%	19.6%	18.4%	20.3%	21.3%	29.8%	27.8%	27.8%	50.3	<0.0001
	Caesarean	50.4%	51.2%	50.5%	49.7%	48.8%	50.1%	50.3%	50.3%	-0.2	<0.0001
	Antepartum complications	12.7%	15.3%	16.0%	17.4%	17.8%	19.0%	20.0%	20.0%	57.7	<0.0001
Medical diseases	4.3%	6.2%	7.6%	9.2%	9.9%	11.7%	13.5%	13.5%	213.5	<0.0001	

Data are percentages of the total number of deliveries unless otherwise stated. Very preterm babies were born after 28–31 completed weeks gestation. Moderate preterm babies were born after 32–33 weeks gestation. Late preterm babies were born after 34–36 weeks gestation.

[†]Adjusted for the sampling distribution of the population.

Table S9: Changes in preterm birth rates and gestational-age-specific caesarean section rates stratified by obstetric complications in singleton pregnancies in primiparous women aged 25-29 years in China, 2012-18

Maternal complications	Characteristics	Year							Change 2012-2018	p value for trend
		2012	2013	2014	2015	2016	2017	2018		
Antepartum complications (n=539144)	No. of deliveries	55346	62559	82249	72148	95006	87199	84637	52.9	..
	Caesarean section rate (per 100 deliveries)									
	28-31 weeks	58.7%	60.1%	59.1%	53.8%	55.1%	58.8%	60.1%	2.5	0.35
	32-33 weeks	64.4%	66.3%	62.9%	63.7%	64.7%	63.6%	61.4%	-4.6	0.04
	34-36 weeks	61.8%	61.7%	57.1%	54.2%	51.7%	53.0%	52.9%	-14.4	<0.0001
	≥ 37 weeks	66.0%	63.7%	57.4%	53.5%	49.7%	48.6%	48.5%	-26.6	<0.0001
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%	1.0%	-8.4	0.04
	Moderate preterm	1.5%	1.4%	1.3%	1.3%	1.2%	1.3%	1.2%	-18.2	<0.0001
	Late preterm	8.6%	7.9%	7.9%	7.8%	7.8%	7.5%	7.6%	-12.3	<0.0001
All preterm	11.2%	10.3%	10.1%	10.0%	10.1%	9.7%	9.7%	-12.7	<0.0001	
Medical diseases (n=177751)	No. of deliveries	13825	18276	26109	23930	32247	30773	32591	135.7	..
	Caesarean section rate (per 100 deliveries)									
	28-31 weeks	24.5%	43.9%	34.6%	35.6%	24.4%	36.4%	47.1%	91.9	0.06
	32-33 weeks	51.0%	52.7%	45.4%	52.5%	46.5%	49.6%	52.1%	2.2	0.48
	34-36 weeks	61.1%	58.7%	57.5%	51.8%	51.9%	55.2%	57.2%	-6.3	0.01
	≥ 37 weeks	57.5%	53.3%	47.1%	42.8%	38.7%	38.8%	37.5%	-34.8	<0.0001
	Preterm birth rate (per 100 deliveries)[†]									
	Very preterm	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%	0.3%	-12.8	0.42
Moderate preterm	0.7%	0.7%	0.5%	0.6%	0.6%	0.4%	0.5%	-25.0	0.0004	

	Late preterm	4.8%	3.9%	3.6%	3.7%	3.6%	3.3%	3.4%	-29.6	<0.0001
	All preterm	5.9%	4.9%	4.4%	4.7%	4.5%	4.1%	4.3%	-27.9	<0.0001

Very preterm babies were born after 28–31 completed weeks gestation. Moderate preterm babies were born after 32–33 weeks gestation. Late preterm babies were born after 34–36 weeks gestation.

[†]Adjusted for the sampling distribution of the population.

Table S10: Changes in preterm birth rates and gestational-age-specific caesarean section rates stratified by obstetric complications in singleton pregnancies in multiparous women aged 25-29 years in China, 2012-18

Maternal complications	Characteristics	Year							Change 2012-2018	p value for trend	
		2012	2013	2014	2015	2016	2017	2018			
Antepartum complications (n=193375)	No. of deliveries	14878	18924	26119	27702	36813	35672	33267	123.6	..	
	Caesarean section rate (per 100 deliveries)										
	28-31 weeks	53.8%	57.9%	55.2%	55.4%	60.9%	59.6%	66.8%	24.1	<0.0001	
	32-33 weeks	69.8%	69.3%	67.8%	69.6%	68.3%	69.7%	70.0%	0.2	0.42	
	34-36 weeks	68.9%	69.2%	67.0%	66.4%	67.1%	67.1%	67.2%	-2.5	0.05	
	≥ 37 weeks	60.3%	58.5%	56.1%	53.5%	51.0%	50.1%	48.4%	-19.8	<0.0001	
	Preterm birth rate (per 100 deliveries)[†]										
	Very preterm	1.9%	1.9%	1.8%	1.5%	1.5%	1.5%	1.6%	-15.6	<0.0001	
	Moderate preterm	2.7%	2.2%	2.3%	2.0%	2.0%	2.0%	1.9%	-27.8	<0.0001	
	Late preterm	10.6%	10.2%	10.2%	9.5%	9.9%	9.7%	9.8%	-7.5	<0.0001	
All preterm	15.1%	14.2%	14.4%	13.1%	13.4%	13.2%	13.3%	-12.1	<0.0001		
Medical diseases (n=75896)	No. of deliveries	3696	5271	8670	10478	14710	15973	17098	362.6	..	
	Caesarean section rate (per 100 deliveries)										
	28-31 weeks	34.5%	54.6%	47.4%	33.3%	38.1%	37.5%	46.0%	33.3	0.47	
	32-33 weeks	52.0%	57.5%	52.2%	49.3%	50.0%	55.9%	55.0%	5.7	0.38	
	34-36 weeks	69.8%	68.6%	62.7%	66.7%	63.3%	62.0%	65.3%	-6.5	0.05	
	≥ 37 weeks	54.7%	54.2%	53.8%	51.4%	50.9%	48.9%	47.5%	-13.3	<0.0001	
	Preterm birth rate (per 100 deliveries)[†]										
	Very preterm	0.6%	0.5%	0.4%	0.4%	0.4%	0.3%	0.3%	-44.3	0.003	
Moderate preterm	0.5%	0.7%	0.7%	0.6%	0.5%	0.6%	0.5%	1.9	0.06		

	Late preterm	5.1%	5.6%	4.3%	3.9%	4.0%	3.9%	3.7%	-28.2	<0.0001
	All preterm	6.3%	6.8%	5.4%	5.0%	4.9%	4.8%	4.6%	-27.2	<0.0001

Very preterm babies were born after 28–31 completed weeks gestation. Moderate preterm babies were born after 32–33 weeks gestation. Late preterm babies were born after 34–36 weeks gestation.

[†]Adjusted for the sampling distribution of the population.

Table S11: Antenatal care in China

	Service provider	Service
First trimester (6-13 weeks)	Primary health care institutions	<ol style="list-style-type: none"> 1. health education 2. maternal health assessment, including: personal health inquiry, risk-factor screening, general physical examination, measurement of blood pressure, weight, and body mass index (BMI), gynecologic examination 3. routine biochemical test and necessary special tests, early pregnancy ultrasound 4. health guidance on lifestyle and mental, and nutritional care 5. guidance for birth defects prevention 6. establishing personal antenatal care records 7. immediate transfer to designated hospitals for high-risk pregnant women
Second trimester (14-27 weeks)	Hospitals	<ol style="list-style-type: none"> 1. analyzing the results of the first antenatal care visit 2. maternal health assessment, including: personal health inquiry, general physical examination, obstetric examination, routine biochemical test and necessary special test, fetal systemic ultrasound screening, fetal growth assessment 3. health education, including: prevention of premature delivery, fetal intrauterine monitoring, delivery-related knowledge, breastfeeding, neonatal care, and newborn screening 4. prevention and treatment of pregnancy-related diseases 5. guidance on health lifestyle, exercise, nutrition, and psychology during pregnancy
Third trimester (28-41 weeks)	Hospitals	<ol style="list-style-type: none"> 1. obstetric examination, fetal growth assessment and monitoring 2. prevention and treatment of pregnancy-related diseases 3. prenatal ultrasound examination, non-stress testing (once a week) 4. health education, including: delivery related knowledge, guidance on delivery mode, fetal growth monitoring, breastfeeding, neonatal care, newborn immunization, and guidance on puerperium care

Table S12: Maternal sociodemographic characteristics stratified by frequency of antenatal visits in all pregnancies in China, 2012-18

Characteristics	Number of antenatal visits				
	None	1-3	4-6	7-9	≥10
Region					
East	30524(1.1%)	166055(5.9%)	578826(20.7%)	713359(25.5%)	1229598(44.0%)
Central	44881(1.2%)	250764(6.5%)	1434595(37.4%)	1292401(33.7%)	714746(18.7%)
West	43156(1.4%)	219699(7.3%)	792666(26.3%)	905655(30.0%)	954337(31.6%)
Maternal education					
Illiterate	3137(6.7%)	10773(23.0%)	19176(41.0%)	7647(16.3%)	4496(9.6%)
Primary school	10194(3.6%)	52870(18.5%)	119870(41.9%)	61910(21.6%)	33415(11.7%)
Middle school	55955(1.8%)	332518(10.9%)	1313159(43.2%)	830161(27.3%)	450046(14.8%)
High school	27198(1.1%)	151404(5.8%)	836391(32.3%)	867595(33.5%)	658264(25.4%)
College or higher	20517(0.6%)	85720(2.5%)	504979(14.5%)	1100224(31.7%)	1662315(47.9%)
No data	1560(0.8%)	3233(1.6%)	12512(6.2%)	43878(21.7%)	90145(44.5%)
Marital status					
Married	113557(1.2%)	616733(6.5%)	2767110(29.1%)	2875678(30.2%)	2867802(30.2%)
Single, widowed, or divorced	4977(3.7%)	19689(14.7%)	38679(28.9%)	35190(26.3%)	30193(22.6%)
No data	27(1.5%)	96(5.2%)	298(16.0%)	547(29.4%)	686(36.8%)
Maternal age (years)					
<20	7345(3.1%)	36913(15.5%)	105712(44.3%)	56330(23.6%)	26402(11.1%)
20-24	30477(1.7%)	166909(9.0%)	713639(38.5%)	524192(28.3%)	370333(20.0%)
25-29	38269(1.0%)	214802(5.5%)	1084947(27.6%)	1219645(31.0%)	1267200(32.2%)
30-34	21152(0.9%)	117280(5.2%)	545174(24.0%)	707266(31.1%)	815149(35.8%)
35-39	10079(1.2%)	53403(6.1%)	214662(24.6%)	272991(31.3%)	290911(33.3%)
40-44	3096(1.6%)	14661(7.8%)	49643(26.3%)	57843(30.7%)	55737(29.6%)
45-49	290(2.4%)	1335(11.0%)	3571(29.4%)	3656(30.1%)	2849(23.4%)
No data	7853(2.9%)	31215(11.4%)	88739(32.5%)	69492(25.5%)	70100(25.7%)
Parity					
Primiparous	52871(1.0%)	271045(5.0%)	1380309(25.4%)	1673969(30.8%)	1913546(35.2%)
Multiparous	65547(1.6%)	365290(8.7%)	1425371(34.0%)	1236777(29.5%)	984520(23.5%)
No data	143(1.3%)	183(1.7%)	407(3.7%)	669(6.1%)	615(5.6%)
Type of pregnancy					
Singleton	116204(1.2%)	626780(6.6%)	2763135(29.2%)	2855554(30.1%)	2847112(30.1%)
Multiple	2357(1.4%)	9721(5.7%)	42907(25.2%)	55821(32.7%)	51545(30.2%)
No data	0(0.0%)	17(12.3%)	45(32.6%)	40(29.0%)	24(17.4%)

Data are n(%).