International Journal of Women's Health

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Trend of Cesarean Section Rates and Related Factors Among First-Time Mothers with Single Pregnancies in Zhejiang Province, China: Evidences from a Multi-Center Study

Bingqing Liu*, Mustafe Abdalle Abdi*, Yuanying Ma

Women's Hospital School of Medicine Zhejiang University, Hangzhou, Zhejiang, People's Republic of China

*These authors contributed equally to this work

Correspondence: Yuanying Ma, Women's Hospital, Zhejiang University School of Medicine, Xueshi Road 1, Hangzhou, Zhejiang Province, 310003, People's Republic of China, Email mayuanying88@zju.edu.cn

Purpose: The overuse of cesarean section (C-section) is a worldwide public health concern, the most effective measure lies in reducing the rate among primiparous women. We aimed to describe the trend, propose reference values and analyze risk factors of C-section among primiparous women in Zhejiang Province, China.

Patients and Methods: We used data of China's National Maternal Near-Miss Surveillance System from 2012 to 2021. The C-Model was used to calculate the reference values, and logistic regression analysis was employed to explore risk factors.

Results: The C-section rate for primiparous women initially decreased and then rose again, the average rate was 36.1%, with a reference C-section rate of 11.8%. In addition to recognized indications for C-section, we also identified advanced maternal age (OR: 3.21, 95% CI: 3.08, 3.35), higher hospital level (OR: 1.15, 95% CI: 1.13, 1.17), higher education level [college or above: 1.05 (1.02, 1.07); high school: 1.1 (1.08, 1.13)], history of abortion (OR: 1.30, 95% CI: 1.28, 1.32), and male infant (OR: 1.15, 95% CI: 1.13, 1.16) as independent risk factors.

Conclusion: Reducing the C-section rate for primiparous women by two-thirds was possible in Zhejiang. Systemic health policies were urgently needed to further reduce the C-section rate.

Keywords: maternal, C-section, reference C-section rate, C-model, risk factors

Introduction

Cesarean section (C-sections) is the most common abdominal surgery procedure performed around the world. Globally about 21.1% of women give birth by C-section.[1,2] The World Health Organization (WHO) suggests a C-section rate between 5% and 15%; a rate above 15% implies an unnecessary and unjustified use of surgical delivery, whereas a rate below 5% may be related to the population's lack of access to medical technology.[3] According to another study conducted by WHO among 24 countries in 2010 from Asia, Europe and Latin America, China had the highest overall C-section (46.2%).[4] According to the data from the National Maternal & Child Health Statistics data set, the C-section rate in China increased from 28.8% to 34.9% between 2008 and 2014.[5] Moreover, in 2008, the C-section rate was even higher, in Chinese urban women with a rate of 64.1%.[6] Thus, the overuse of C-section has become an important public health concern in China.

In recent years, according to some nationwide studies, there has been a decline in the C-section rate in China.[7–9] Previous research often attributed the decrease in C-section rates to changes in China's population policy.[8,10] After more than 30 years of implementing the one-child policy, China, in 2013, started implementing the selective two-child policy due to concerns about declining birth rates and an aging population.[11] The universal two-child policy was initiated in

Received: 24 October 2024
Accepted: 15 May 2025
Published: 4 June 2025

October of 2015.[11] Previous studies suggested that the implementation of the two-child policy, led to a surge in demand for second pregnancies, contributing to the observed decline in C-section rates in recent years. However, most of these studies focused on the period shortly after the introduction of the universal two-child policy. However, after the increase in births following the change in the policy during 2016–2017, the birth rate has now reduced nationally.[12] This indicated that the fertility demand unleashed by the universal two-child policy in recent years had subsided, and the C-section rate might have also undergone changes accordingly. Therefore, it was necessary to describe the trend in C-section rates over a longer time frame.

Modelling suggested that reducing the risk of the first C-section delivery during labour was the most effective strategy for reducing the overall rate.[13,14] Therefore, this study focused on the population of primiparous women. Utilizing the monitoring of data in China's National Maternal Near-Miss Surveillance System (NMNMSS) for Zhejiang Province for the period between 2012 and 2021, the research described the changing trend in the C-section rate among primiparous women in Zhejiang Province, China. The present study also calculated reference values and explored relevant risk factors, aiming to identify the factors that contributed to the changes in the C-section rate and discovered key areas for further reducing the C-section rate.

Materials and Methods

Study Population

The data of this study obtained from NMNMSS for Zhejiang Province. The NMNMSS was established in October 2010 and covered 326 urban districts and rural counties across China. Hospitals with more than 1000 deliveries per year were eligible to be surveillance sites, and all the eligible hospitals were selected via stratified random sampling to ensure proportional representation of urban and rural populations across all three regions in China (eastern, central, and western). In Zhejiang Province, 18 out of 85 eligible hospitals which were randomly sampled, consisting of 11 tertiary and 7 secondary hospitals (12 county level, 4 municipal level, 2 provincial level). Trained doctors and nurses would fill out a questionnaire consisting of information about demographic, reproductive history, pregnancy complications, and birth outcomes from all the pregnant and postpartum women in the 18 surveillance sites by referring to the medical record, and entered the data into a web-based data management system. Local staffs of NMNMSS were responsible for verifying the quality of data. County-level, municipal, and provincial staffs of NMNMSS in Zhejiang Province visited all of the 18 surveillance sites at least once a year to check the accuracy of monitoring information by cross-checking with medical records. The National Office for Maternal and Child Health Surveillance also visited a random sample of six to eight hospitals in each province once a year to ensure the quality assurance. Detailed information about the data collection and quality control process has been reported elsewhere.[15]

This study was approved by the ethics committee of the West China Second University Hospital (protocol ID, 2012008). All needed data were extracted from hospital's electric medicine records without any patient identification. Therefore, this study did not obtain informed consent from individual patients.

Between January 2012 and December 2021, 865,208 pregnancy termination (including full-term delivery, spontaneous abortion, induced abortion, and preterm birth, and other cases of pregnancy ending) in the 18 surveillance sites of Zhejiang Province (Figure 1). We excluded multiparous women (n = 392,113), women had incorrect (number of parities > number of gravidity) (n = 0) or missing data on parity (n = 765), and women with multiple pregnancy (n = 11,821). Of 460,509 primiparous singleton pregnancy women, 19,763 were miscarriage, 1878 with gestational age was less than 28 weeks or over 43 weeks, 368 had missing information on gestational age, 43 had incorrect data on maternal age (age < 13 years or > 50 years), 1101 did not deliver in the surveillance sites, these cases were excluded for the final analysis. The remaining 437,356 mothers and birth pairs were included in the analysis.

Assessment of Study Variables

Advanced maternal age was defined as women older than 35 years old. The diagnosis of uterine rupture, placenta previa, placental abruption, hypertensive disorder, diabetes, heart disease, liver disease, lung disease, fetal presentation was based on physician diagnosis, and that information were obtained from the medical record. Pregnant women with chronic

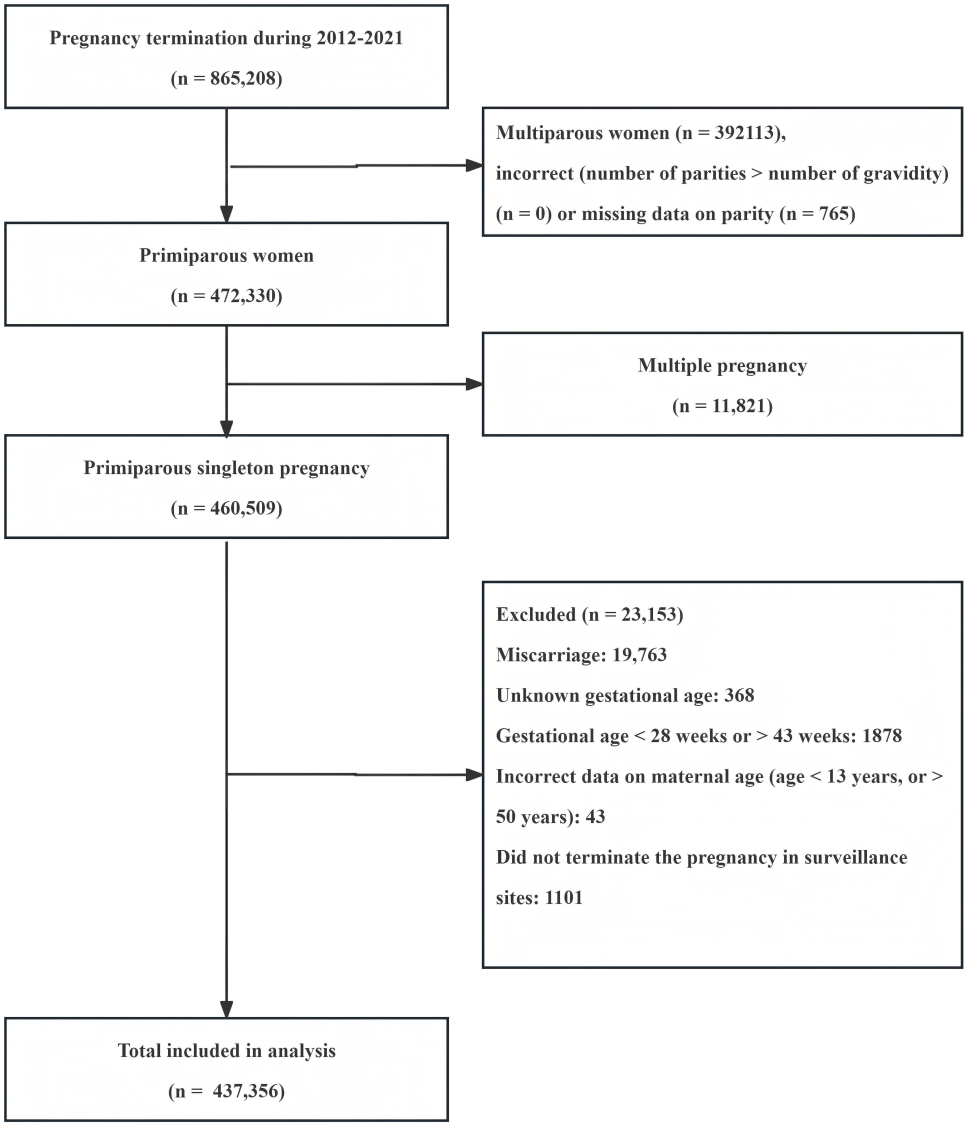

Figure 1 Study Population.

hypertension, hypertension during pregnancy, preeclampsia, eclampsia, and HELLP syndromes were defined as hypertensive disorder. Pregnant women with chronic diabetes and gestational diabetes were diagnosed as diabetes. Maternal near miss (MNM) was defined according to WHO criteria.[16] Macrosomia was defined as newborns with gestational weight above 4000 g. Cephalic C-section refers to the use of C-section to terminate pregnancy in women with fetus had a cephalic presentation.

Calculating the Reference C-Section Rate

This study utilized the mathematical model proposed by the WHO in 2015, known as the C-Model, to calculate the reference C-section rate.[13,17] The model comprehensively considered demographic characteristics, obstetric factors, and complications, generating a locally "appropriate" C-section rate for the studied population. Constructed using data from 22 countries and validated with data from 43 countries, C-model demonstrated good discriminatory capacity with an AUC ranging from 0.832 to 0.844. This study employed the most complete version (v1.3) of the model, and the reference C-section rate was calculated using the following formula: Logit = -4.015252–0.77531*parity + 2.922222*previous

C-section + 1.834027*multiple pregnancy + 2.634921*provider-initiated childbirth + 2.985162*fetal presentation + 0.71104*maternal age + 0.661417*organ dysfunction or ICU admission + 3.796513*placenta previa + 2.741255*abruptio placentae + 0.561991*chronic hypertension + 0.98718*pre-eclampsia + 1.301346*renal disease + 1.310211*HIV. Prob(C-section) = eLogit/(1 + eLogit).

Statistical Analysis

We charted the monthly average cesarean section to visualize the characteristics of temporal distribution. The denominator for both the primiparous C-section and cephalic C-section rates is the total number of singleton primiparous women during the corresponding time period. We calculated the excess C-section rate using the following formula: Excess C-section rate = Primiparous C-section rate - Reference C-section rate, and plotted a scatter diagram of the excess C-section rate over time. Categorical and numerical variables were expressed as number (percentage) and mean ± standard deviation (SD), respectively. Differences in proportions and means between C-section and vaginal delivery were tested by χ^2 test or the analysis of variance. We used logistic regression models to investigate the risk factors of C-section among primiparous women. The unadjusted model was used to summarize the crude odds ratios without adjustment of any covariates. In the adjusted model, we included hospital type, education, advanced maternal age, gravidity, uterine rupture, placenta previa, placental abruption, hypertensive disorder, diabetes, heart disease, liver disease, lung disease, fetal presentation, maternal near miss, newborn sex, and macrosomia. Population-attributable risk (PAR) was calculated based on logistic model, to show the proportion of the C-section rate that was attributable to a given exposure. To further evaluate the importance of each factor, we adopted the dominance analysis method by Razia Azen and Nicole Traxel.[18] A detailed description of the method for analyzing strengths is provided in the supplementary materials. All analyses were conducted using R software (version 3.2.2; https://www.r-project.org/). Statistical significance was determined using a two-side probability set at $P < 0.05$.

Results

Changes in C-Section Rate Among Primiparous Women

Between January 2012 and December 2021, there were 157,916 (36.1%) primiparous women accepted C-section in 18 surveillance sites, and the cephalic C-section rate was 142,766 (33.8%), while during the same period, the reference C-section rate calculated according to the C-Model was 11.8%. The C-section rates were visually inspected as a trend of decline, reaching a nadir, and then rising. The period with the lowest C-section rate among primiparas was 2015–2019, with an average C-section rate of 32.4% during this period (Figure 2). The average level of C-section rates were 40.4%, 32.4% and 36.6% in the period between 2012 and 2014, 2015–2019 and 2020–2021, respectively. The cephalic C-section rates share the same decrease-bason-increase trend. Compared to the average rate from 2015 to 2019, the cephalic C-section rate increased by 12.4% (30.1% vs 33.8%) on a quarter-to-quarter basis during 2020–2021. The trend of the excess C-section rate is similar to that of the C-section rate among primiparas and the cephalic C-section rate among primiparas (Figure 3).

The Risk Factors of C-Section Among Primiparous Women

In univariate analysis (Tables 1 and 2), higher hospital level, higher education background, advanced maternal age, history of miscarriage or induced labor, uterine rupture, placenta previa, placental abruption, hypertensive disorder, gestational diabetes, heart disease, liver disease, lung disease, fetal malpresentation, MNM, male fetus, and macrosomia were associated with an increased risk of C-section. After incorporating the above factors into a multiple regression model (Table 2), uterine rupture was no longer a risk factor for C-section in primiparous women. However, the relationships with other factors and C-section in primiparous women remained significant.

Contributions of Risk Factors to the C-Section Rate

The PAR was shown in Table 3. More than 1 C-section per 100 primiparous women could be attributed to factors such as hospital type (PAR: 5.60, 95% CI: 4.88, 6.32), advanced maternal age (PAR: 2.13, 95% CI: 2.05, 2.22), history of abortion

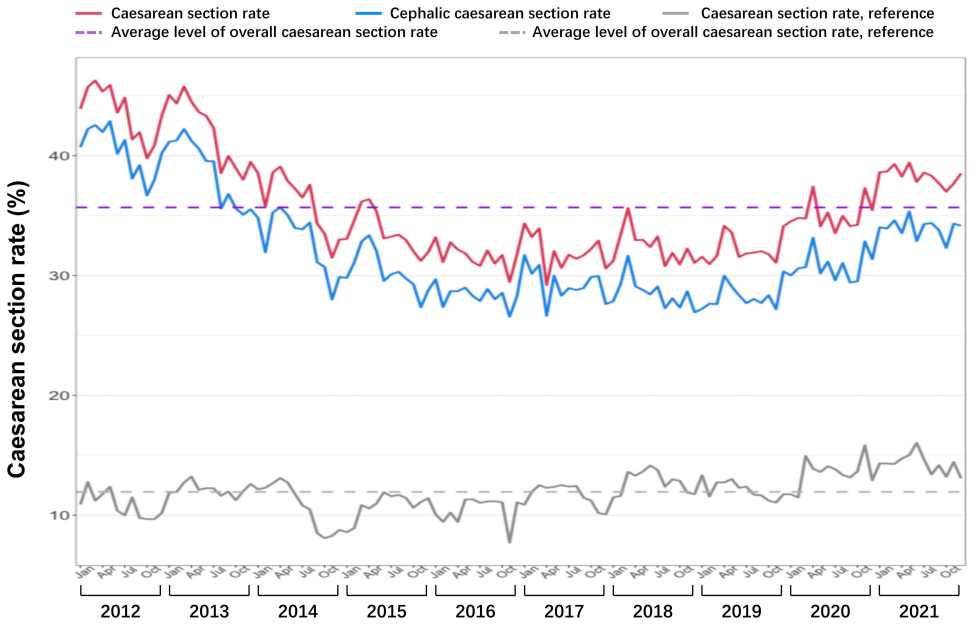

Figure 2 Changes in the Cesarean Section Rate.

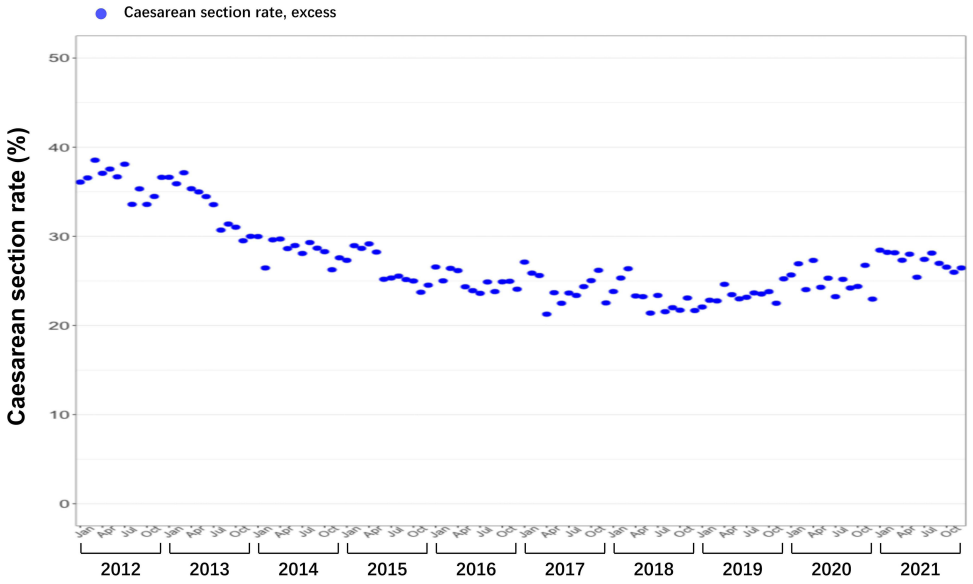

Figure 3 Changes in the excess Cesarean Section Rate.

(PAR: 4.75, 95% CI: 4.47, 5.03), placenta previa (PAR: 1.40, 95% CI: 1.34, 1.45), hypertensive disorder (PAR: 3.19, 95% CI: 3.09, 3.30), breech presentation (PAR: 5.70, 95% CI: 5.60, 5.81), male infant (PAR: 3.93, 95% CI: 3.51, 4.34), and macrosomia (PAR: 3.81, 95% CI: 3.70, 3.92). The proportion of C-section that were the result of advanced maternal age, hypertensive disorder and breech presentation increased over the study period. To further evaluate the importance of each factor, we included variables with a population attributable risk greater than 2% in the dominance analysis. The analysis results are shown in Table S1. Through dominance analysis, we found that tertiary hospitals and advanced maternal age are strong risk factors for C-section rates in primiparas, with average contributions to the model of 0.075 and 0.073, respectively.

https://doi.org/10.2147/IJWH.S497765

Table 1 Maternal Demographics and Pregnancy Outcomes Among Study Population

Characteristics	N	Vaginal Delivery	Caesarean Section	*P*
Hospital type				< 0.001
Secondary hospital	95342	64,448 (67.6%)	30,894 (32.4%)	
Tertiary hospital	307484	192,442 (62.6%)	115,042 (37.4%)	
Education				< 0.001
College or above	283551	181,081 (63.9%)	102,470 (36.1%)	
High school	74150	46,787 (63.1%)	27,363 (36.9%)	
Middle school or below	68737	44,887 (65.3%)	23,850 (34.7%)	
Advanced maternal age				< 0.001
No	393506	254,342 (64.6%)	139,164 (35.4%)	
Yes	12264	4006 (32.7%)	8258 (67.3%)	
History of abortion				< 0.001
No	297032	197,039 (66.3%)	99,993 (33.7%)	
Yes	140324	82,401 (58.7%)	57,923 (41.3%)	
Uterine rupture				0.0017
No	437321	279,427 (63.9%)	157,894 (36.1%)	
Yes	35	13 (37.1%)	22 (62.9%)	
Placenta previa				< 0.001
No	433238	279,214 (64.4%)	154,024 (35.6%)	
Yes	4118	226 (5.5%)	3892 (94.5%)	
Placental abruption				< 0.001
No	433667	278,050 (64.1%)	155,617 (35.9%)	
Yes	3689	1390 (37.7%)	2299 (62.3%)	
Hypertensive disorder				< 0.001
No	417702	272,322 (65.2%)	145,380 (34.8%)	
Yes	19654	7118 (36.2%)	12,536 (63.8%)	
Heart disease				< 0.001
No	435407	278,790 (64%)	156,617 (36%)	
Yes	1949	650 (33.4%)	1299 (66.6%)	
Liver disease				< 0.001
No	431556	276,392 (64%)	155,164 (36%)	
Yes	5800	3048 (52.6%)	2752 (47.4%)	
Gestational diabetes				< 0.001
No	400166	258,451 (64.6%)	141,715 (35.4%)	
Yes	37190	20,989 (56.4%)	16,201 (43.6%)	
Lung disease				< 0.001
No	437203	279,393 (63.9%)	157,810 (36.1%)	
Yes	153	47 (30.7%)	106 (69.3%)	
Maternal near miss				< 0.001
No	435039	278,490 (64%)	156,549 (36%)	
Yes	2317	950 (41%)	1367 (59%)	
Fetal presentation				< 0.001
Cephalic presentation	421350	278,584 (66.1%)	142,766 (33.9%)	
Breech presentation	14994	730 (4.9%)	14,264 (95.1%)	
Shoulder presentation	685	98 (14.3%)	587 (85.7%)	
Mixed presentation	327	28 (8.6%)	299 (91.4%)	
Newborn sex				< 0.001
Female	211503	138,391 (65.4%)	73,112 (34.6%)	
Male	225822	141,030 (62.5%)	84,792 (37.5%)	
Macrosomia				< 0.001
No	416740	272,117 (65.3%)	144,623 (34.7%)	
Yes	20513	7245 (35.3%)	13,268 (64.7%)	

Table 2 Risk Factors of Caesarean Section Among Primiparae

Characteristics	Unadjusted Model		Adjusted Model	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Hospital type				
Secondary hospital	Ref		Ref	
Tertiary hospital	1.25 (1.23,1.27)	< 0.001	1.15 (1.13,1.17)	< 0.001
Education				
College or above	1.07 (1.05, 1.08)	< 0.001	1.05 (1.02,1.07)	< 0.001
High school	1.1 (1.08, 1.12)	< 0.001	1.1 (1.08,1.13)	< 0.001
Middle school or below	Ref		Ref	
Advanced maternal age				
No	Ref	Ref	Ref	Ref
Yes	3.77 (3.63,3.91)	< 0.001	3.21 (3.08,3.35)	< 0.001
History of abortion				
No	Ref	Ref	Ref	Ref
Yes	1.39 (1.37,1.4)	< 0.001	1.3 (1.28,1.32)	< 0.001
Uterine rupture				
No	Ref	Ref	Ref	Ref
Yes	2.99 (1.51,5.95)	< 0.001	2.21 (0.96,5.09)	0.0629
Placenta previa				
No	Ref	Ref	Ref	Ref
Yes	31.22 (27.3,35.7)	< 0.001	30.72 (26.49,35.62)	< 0.001
Placental abruption				
No	Ref	Ref	Ref	Ref
Yes	2.96 (2.76,3.16)	< 0.001	2.87 (2.66,3.11)	< 0.001
Hypertensive disorder				
No	Ref	Ref	Ref	Ref
Yes	3.3 (3.2, 3.4)	< 0.001	3.28 (3.17,3.4)	< 0.001
Heart disease				
No	Ref	Ref	Ref	Ref
Yes	3.56 (3.24,3.91)	< 0.001	3.48 (3.11,3.88)	< 0.001
Liver disease				
No	Ref	Ref	Ref	Ref
Yes	1.61 (1.53,1.69)	< 0.001	1.59 (1.5,1.69)	< 0.001
Gestational diabetes				
No	Ref	Ref	Ref	Ref
Yes	1.41 (1.38,1.44)	< 0.001	1.14 (1.11,1.17)	< 0.001
Lung disease				
No	Ref	Ref	Ref	Ref
Yes	3.99 (2.83,5.63)	< 0.001	2.66 (1.79,3.96)	< 0.001
Maternal near miss				
No	Ref	Ref	Ref	Ref
Yes	2.56 (2.36,2.78)	< 0.001	2.47 (2.18,2.8)	< 0.001
Fetal presentation				
Cephalic presentation	Ref		Ref	
Breech presentation	38.13 (35.39, 41.08)	< 0.001	45.78 (42,49.89)	< 0.001
Shoulder presentation	11.69 (9.44, 14.48)	< 0.001	7.41 (5.86,9.36)	< 0.001
Mixed presentation	20.84 (14.14, 30.7)	< 0.001	18.89 (12.14,29.4)	< 0.001
Sex				
Female	Ref	Ref	Ref	Ref
Male	1.14 (1.12,1.15)	< 0.001	1.15 (1.13,1.16)	< 0.001
Macrosomia				
No	Ref	Ref	Ref	Ref
Yes	3.45 (3.35,3.55)	< 0.001	3.74 (3.61,3.86)	< 0.001

https://doi.org/10.2147/IJWH.S497765

Table 3 Population-Attributable Risks for Risk Factors by Time Period

Characteristics	2012–2013	2014–2015	2016–2017	2018–2019	2020–2021	2012–2021
Hospital type						
Secondary hospital	Ref	Ref	Ref	Ref	Ref	Ref
Tertiary hospital	2.94 (1.73, 4.15)	10.09 (8.67, 11.51)	6.24 (4.43, 8.06)	−0.86 (−2.9, 1.19)	4.52 (2.39, 6.65)	5.60 (4.88, 6.32)
Education						
College or above	1.72 (1.29, 2.14)	0.95 (0.49, 1.42)	0.60 (0.01, 1.19)	0.60 (−0.07, 1.27)	0.50 (−0.17, 1.17)	0.95 (0.72, 1.19)
High school	10.53 (9.48, 11.58)	1.44 (−0.07, 2.95)	−2.73 (−4.87, −0.6)	−2.29 (−4.61, 0.03)	−1.71 (−4.56, 1.15)	1.66 (0.9, 2.43)
Middle school or below	Ref	Ref	Ref	Ref	Ref	Ref
Advanced maternal age						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.38 (1.27, 1.49)	1.86 (1.69, 2.02)	2.58 (2.36, 2.81)	2.97 (2.71, 3.24)	3.41 (3.12, 3.7)	2.13 (2.05, 2.22)
History of abortion						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	4.74 (4.25, 5.22)	4.96 (4.37, 5.55)	4.97 (4.25, 5.69)	4.22 (3.46, 4.97)	3.7 (2.97, 4.43)	4.75 (4.47, 5.03)
Placenta previa						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.04 (0.97, 1.12)	1.39 (1.28, 1.5)	1.92 (1.76, 2.07)	1.5 (1.35, 1.66)	1.43 (1.28, 1.57)	1.4 (1.34, 1.45)
Placental abruption						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.25 (0.2, 0.3)	0.48 (0.4, 0.57)	0.74 (0.61, 0.86)	0.94 (0.79, 1.08)	0.76 (0.61, 0.92)	0.52 (0.48, 0.56)
Hypertensive disorder						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	2.48 (2.34, 2.63)	3.25 (3.04, 3.46)	3.65 (3.38, 3.92)	3.63 (3.32, 3.93)	4.08 (3.75, 4.4)	3.19 (3.09, 3.3)
Heart disease						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.28 (0.23, 0.32)	0.31 (0.24, 0.38)	0.41 (0.32, 0.49)	0.47 (0.37, 0.58)	0.19 (0.11, 0.27)	0.32 (0.29, 0.35)
Liver disease						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.24 (0.18, 0.3)	0.19 (0.08, 0.29)	0.75 (0.59, 0.9)	0.7 (0.54, 0.87)	0.45 (0.31, 0.59)	0.35 (0.3, 0.4)
Gestational diabetes						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.35 (0.2, 0.51)	1.17 (0.93, 1.42)	1.31 (0.98, 1.63)	1.16 (0.77, 1.56)	0.9 (0.47, 1.34)	0.61 (0.49, 0.74)
Lung disease						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0 (−0.01, 0.02)	0.02 (0, 0.03)	0.02 (0, 0.04)	0.02 (−0.01, 0.04)	0.05 (0.02, 0.08)	0.02 (0.01, 0.03)
Maternal near miss						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.13 (0.09, 0.17)	0.19 (0.13, 0.24)	0.25 (0.18, 0.31)	0.18 (0.09, 0.26)	0.2 (0.13, 0.28)	0.18 (0.15, 0.2)
Fetal presentation						
Cephalic presentation	Ref	Ref	Ref	Ref	Ref	Ref
Breech presentation	3.99 (3.84, 4.15)	5.89 (5.66, 6.13)	5.93 (5.65, 6.21)	7.81 (7.47, 8.15)	7.04 (6.73, 7.36)	5.7 (5.6, 5.81)
Shoulder presentation	0.07 (0.04, 0.1)	0.11 (0.07, 0.15)	0.1 (0.06, 0.14)	0.25 (0.19, 0.31)	0.33 (0.26, 0.4)	0.15 (0.13, 0.17)
Mixed presentation	0.07 (0.05, 0.1)	0.09 (0.06, 0.12)	0.07 (0.04, 0.11)	0.06 (0.02, 0.09)	0.2 (0.15, 0.25)	0.1 (0.08, 0.11)
Sex						
Female	Ref	Ref	Ref	Ref	Ref	Ref
Male	3.45 (2.74, 4.16)	4.6 (3.71, 5.48)	3.79 (2.73, 4.84)	4.35 (3.22, 5.47)	3.48 (2.38, 4.58)	3.93 (3.51, 4.34)
Macrosomia						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	3.02 (2.85, 3.19)	3.84 (3.6, 4.07)	4.21 (3.92, 4.5)	4.81 (4.49, 5.14)	3.96 (3.68, 4.25)	3.81 (3.7, 3.92)

Discussion

In the present study, the C-section rate among primiparous women was 36.1%, almost triple the average reference rate from the C-Model. Over the span of 2012–2021, the C-section rates were visually inspected as a trend of decline, reaching a nadir, and then rising. Besides known medical indications, non-indications like abortion history, advanced

maternal age, and sociodemographic factors (higher hospital and education levels, male infants) were identified as independent risk factors. These factors have a high PAR, indicating significant public health impact and potential for prevention if addressed.

The global rise in C-section rates over recent decades has drawn public health attention. This increase, alongside disparities in rates across countries, regions, and hospitals, has been widely documented. Our study found a 36.1% C-section rate among 157,916 primiparous women in Zhejiang province, higher than Canada's 24%[19] but below China's national average.[7–9] The trend showed fluctuations: a decline from 2012 to 2016, aligning with Liang et al[9] and Yan et al's findings[7] based on national data, yet conflicting with Long et al's results from the National Household Health Services Survey.[8] These discrepancies likely stem from differing survey methods. Long et al obtained information on C-section from self-reported data of pregnant women who gave birth within the past 5 years in their study, while Liang et al and Yan et al sourced their data on C-section from medical records and self-reported information of the current year. All studies, however, noted a significant drop in the C-section rate among primiparous women. While Long et al linked this decrease to China's relaxed birth policies, coupled with an increase in demand for second births,[8,10] our study and others found the decline occurred during the selective two-child policy period, with no notable change after the universal two-child policy was implemented. This suggests Long et al's study design may have introduced a lag effect, leading to potential misattribution of the reasons behind the C-section rate decrease.

China is one of the few countries that has reversed the upward trend in C-section rates. The decline in C-section rates among primiparous women from 2012 to 2016 should not be simply linked to relaxed birth policies. A cross-sectional study on C-section rates in Guangdong Province from 2008 to 2016 found no immediate effect of the universal two-child policy on local C-section rates.[20] However, after the Guangzhou Health Commission introduced public health education, professional skills training, and technical support for medical facilities, the local C-section rate fell markedly.[20] From 2009 to 2014, China implemented measures to reduce C-section rates, including setting assessment targets, promoting midwifery techniques, and revising clinical guidelines for C-section indications. These steps, involving governments and obstetric societies, established C-section rate goals, introduced relevant policies, and used financial incentives to achieve these targets. China also promoted midwifery through training centers and regulated C-section indications by issuing expert consensus on diagnosing prolonged labor.[21,22] Through this series of top-down measures, China witnessed a significant decline in C-section rates.[8,9] Notably, this study observed an upward trend in C-section rates among primiparous women since 2020, a finding echoed by Yan et al from 2019. This might be attributed to the rising proportion of elderly and high-risk pregnant women in China,[23,24] and the changing trend in the reference C-section rate might supported this hypothesis. Over time, the impact of these high-risk factors might have outweighed the effects of various protective measures. Additionally, other factors should not be overlooked contributing to this upward trend. On July 10, 2019, Zhejiang Province issued the "Opinions on Promoting the Reform of Basic Medical Insurance Payment Methods in the Province's County Medical Community.[25] The implementation of the Diagnosis-Related Groups points system was introduced at the provincial level. C-section procedures would increase the Diagnosis-Related Groups payment ratio, generating more surplus within medical groups. This factor could potentially diminish the motivation of clinical doctors to promote vaginal deliveries, contributing to the observed increase in C-section rates in 2020–2021.

Reducing the C-section rate is a systematic and long-term effort. Previous measures have primarily targeted healthcare professionals, including doctors, midwives, hospital administrators, and healthcare system officials. These measures, focused on enhancing midwifery skills, providing performance incentives, and revising surgical indications which had created a medical environment conducive to promoting safe vaginal deliveries. Though effective, the rise in C-section rates among primiparous women in 2020–2021 indicates that enhancing the medical environment alone is insufficient for controlling C-section rates. Even during the decline from 2016 to 2019, Zhejiang Province's C-section rate for primiparous women remained at approximately 33%, much higher than the C-model - recommended rate. This underscores the need for additional protective measures to reduce C-section rates.

Examining C-section influencing factors in primiparous women can help develop targeted interventions. Our study revealed that abortion history and advanced maternal age are independent C-section risk factors for primiparous women. None of the above factors were surgical indications for C-section,[4,26–30] which suggested that clinical criteria for

C-section indications might be overly broad. Future efforts could involve obstetric quality control centers to tighten C-section indication control. Moreover, certain social factors, such as hospital level, higher education, and male infant gender, were also identified as independent C-section risk factors, indicating the need to build a society more supportive of vaginal delivery. Further calculations of PAR for each independent factor, revealed high population attributable risk for non-indication factors such as history of abortion, advanced maternal age, hospital level, and infant sex. Particularly, advanced maternal age demonstrated a rising trend in PAR for C-section among primiparous women over the years, highlighting the need to focus on this subgroup in the next steps of obstetric quality control. Analysis of the PAR for educational level on C-sections among primiparous women revealed that higher education had a higher PAR in 2012–2013, followed by a downward trend in subsequent years. By 2020–2021, the impact of higher education on the PAR for C-sections among primiparous women was no longer significant, suggesting that recent health education efforts to promote vaginal childbirth have had some success. However, it was noteworthy that after accounting for other risk factors, the PAR for C-section among primiparous women was still significant for deliveries in tertiary hospitals and for male infants, with PARs of 4.52 and 3.48, respectively, in 2020–2021. Previous studies had also found that C-section rates were often higher in tertiary or private hospitals compared to secondary or public hospitals.` As this study utilized cross-sectional data, causality can never be determined by this study design, only associations. The relationship between them may have been due to the preference of pregnant women seeking C-section to choose hospitals with higher medical standards. The relationship between delivering male infants and the C-section rate might be due to a greater demand for subsequent pregnancies among pregnant women delivering girls, leading them to prefer vaginal delivery for their first childbirth.

This study examined the long-term trend of C-section rates among primiparous women in Zhejiang Province, China, using the internationally recognized C-model to calculate reference values. This approach offers a comprehensive assessment of the reasons behind the decline in C-section rates in China and provides a basis for further goal setting and evaluation. However, the study has limitations. Data were only collected from Zhejiang Province, limiting the generalizability of the results. Despite this, the identified trends align with nationwide studies in China, and the methodology can be applied elsewhere. Additionally, the study could not differentiate between C-sections based on medical indications and maternal request, hindering targeted risk factor analysis. Nevertheless, using the WHO's C-model, the study calculated reference C-section rates considering obstetric, complication, and sociodemographic factors, offering a reference for setting target C-section rates among primiparous women. Finally, the study did not consider factors like maternal BMI and gestational weight gain, which are associated with C-section incidence and modifiable. Quantifying their impact would be crucial for future intervention measures.

Conclusion

Between 2012 and 2021, the C-section rate among primiparous women in Zhejiang exhibited a trend of decline, reaching a nadir, and then rising, yet never reached the C-model - recommended rate. Non-indication factors like advanced maternal age, abortion history, hospital level, higher education, and male infant gender were found to significantly impact the population attributable risk. China is one of the few countries to reverse its upward C-section trend. The measures taken have fostered a medical environment favoring vaginal delivery. To further reduce C-section rates, future policies should focus on: 1. Strengthening obstetric quality control measures, with a particular emphasis on enhancing the quality control of C-section indications for advanced maternal age; 2. Making appropriate adjustments to the medical insurance payment system; 3. Most importantly, creating a societal environment conducive to vaginal delivery.

Funding

This work was supported by the National Natural Science Foundation of China [grant numbers: 72204215, 71804162], and Zhejiang Province Public Welfare Technology Application Research Project [grant numbers: LGF22H260007].

Disclosure

The authors report no conflicts of interest in this work.

References

1. Vega ES, Casco S, Chamizo K, Flores-Hernández D, Landini V, Guillén-Florez A. Rising trends of cesarean section worldwide: a systematic review. *Obstet Gynecol Int J*. 2015;3(2):73.
2. Betran AP, Ye J, Moller AB, Souza JP, Zhang J. Trends and projections of caesarean section rates: global and regional estimates. *BMJ Glob Health*. 2021;6(6):e005671. doi:10.1136/bmjgh-2021-005671
3. WHO. *UNFPA, UNICEF, AMDD. Monitoring Emergency Obstetric Care: A Handbook*. Geneva, Switzerland: World Health Organisation; 2009.
4. Wang X, Hellerstein S, Hou L, Zou L, Ruan Y, Zhang W. Caesarean deliveries in China. *BMC Pregnancy Childbirth*. 2017;17(1):1–9. doi:10.1186/s12884-017-1233-8
5. Li HT, Luo S, Trasande L, et al. Geographic variations and temporal trends in cesarean delivery rates in China, 2008-2014. *JAMA*. 2017;317(1):69–76. doi:10.1001/jama.2016.18663
6. Feng XL, Wang Y, An L, Ronsmans C. Cesarean section in the People's Republic of China: current perspectives. *Int J Womens Health*. 2014;6:59–74. doi:10.2147/IJWH.S41410
7. Yan J, Wang L, Yang Y, et al. The trend of caesarean birth rate changes in China after "universal two-child policy" era: a population-based study in 2013-2018. *BMC Med*. 2020;18(1):249. doi:10.1186/s12916-020-01714-7
8. Long Q, Zhang Y, Zhang J, Tang X, Kingdon C. Changes in caesarean section rates in China during the period of transition from the one-child to two-child policy era: cross-sectional National Household Health Services Surveys. *BMJ Open*. 2022;12(4):e059208.
9. 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. doi:10.1136/bmj.k817
10. Tang D, Laporte A, Gao X, Coyte PC. The effect of the two-child policy on cesarean section in China: identification using difference-in-differences techniques. *Midwifery*. 2022;107:103260. doi:10.1016/j.midw.2022.103260
11. Zeng Y, Hesketh T. The effects of China's universal two-child policy. *Lancet*. 2016;388(10054):1930–1938. doi:10.1016/S0140-6736(16)31405-2
12. National Bureau of Statistics of China. China statistical yearbook 2020. Vol. 1. 2020 (in Chinese).
13. Zhang Y, Betran AP, Li X, et al. What is an appropriate caesarean delivery rate for China: a multicentre survey. *BJOG*. 2022;129(1):138–147. doi:10.1111/1471-0528.16951
14. Brick A, Layte R, Nolan A, Turner MJ. Differences in nulliparous caesarean section rates across models of care: a decomposition analysis. *BMC Health Serv Res*. 2016;16:239. doi:10.1186/s12913-016-1494-3
15. Jun Zhu LR. China's maternal and child health surveillance supremo. *Lancet*. 2021;397(10293):2457. doi:10.1016/S0140-6736(21)01162-4
16. Mohan Kumar M, Naik G. Maternal near miss: reaching the last mile. *J Obstet Gynaecol*. 2021;41(5):675–683. doi:10.1080/01443615.2020.1820467
17. Souza JP, Betran AP, Dumont A, et al. A global reference for caesarean section rates (C-Model): a multicountry cross-sectional study. *BJOG*. 2016;123(3):427–436. doi:10.1111/1471-0528.13509
18. Azen R, Traxel N. Using dominance analysis to determine predictor importance in logistic regression. *J Educ Behav Stat*. 2009;34(3):319–347. doi:10.3102/1076998609332754
19. Wood S, Tang S. Changes in the frequency of cesarean delivery in nulliparous women in labor in a Canadian population, 1992-2018. *Obstetrics Gynecol*. 2021;137(2):263–270. doi:10.1097/AOG.0000000000004225
20. Xia X, Zhou Z, Shen S, et al. Effect of a two-stage intervention package on the cesarean section rate in Guangzhou, China: a before-and-after study. *PLoS Med*. 2019;16(7):e1002846. doi:10.1371/journal.pmed.1002846
21. Obstetrics and gynaecology group of the Chinese medical association. Expert consensus on new process standard and handling (2014). *Chin J Obstetrics Gynaecol*. 2014;49(7):486. in Chinese.
22. Obstetrics and gynaecology group of the Chinese medical association. Expert consensus on caesarean section (2014). *Chin J Obstetrics Gynecol*. 2014;49(10):721–724. in Chinese.
23. Luo J, Fan C, Luo M, Fang J, Zhou S, Zhang F. Pregnancy complications among nulliparous and multiparous women with advanced maternal age: a community-based prospective cohort study in China. *BMC Pregnancy Childbirth*. 2020;20(1):581. doi:10.1186/s12884-020-03284-1
24. Li J, Yan J, Jiang W. The role of maternal age on adverse pregnancy outcomes among primiparous women with singleton birth: a retrospective cohort study in urban areas of China. *J Matern Fetal Neonatal Med*. 2023;36(2):2250894. doi:10.1080/14767058.2023.2250894
25. Zhejiang Provincial Medical Security Bureau, Zhejiang Provincial Health Commission, Zhejiang Provincial Department of Finance, Zhejiang Provincial Department of Human Resources and Social Security, Zhejiang Provincial Food and Drug Administration (2019). Opinions on promoting the reform of basic medical insurance payment methods for county-level medical communities in the whole province (in Chinese). Available from: http://ybj.zj.gov.cn/art/2019/7/10/art_1229113757_564134.html. Accessed February 21, 2024.
26. Penn Z, Ghaem-Maghami S. Indications for caesarean section. *Best Pract Res Clin Obstet Gynaecol*. 2001;15(1):1–15. doi:10.1053/beog.2000.0146
27. Hellerstein S, Feldman S, Duan T. Survey of obstetric care and cesarean delivery rates in Shanghai, China. *Birth*. 2016;43(3):193–199. doi:10.1111/birt.12231
28. Gedefaw G, Demis A, Alemnew B, Wondmieneh A, Getie A, Waltengus F. Prevalence, indications, and outcomes of caesarean section deliveries in Ethiopia: a systematic review and meta-analysis. *Patient Saf Surg*. 2020;14:11. doi:10.1186/s13037-020-00236-8
29. Dahlke JD, Mendez-Figueroa H, Rouse DJ, Berghella V, Baxter JK, Chauhan SP. Evidence-based surgery for cesarean delivery: an updated systematic review. *Am J Obstet Gynecol*. 2013;209(4):294–306. doi:10.1016/j.ajog.2013.02.043
30. Berghella V, Baxter JK, Chauhan SP. Evidence-based surgery for cesarean delivery. *Am J Obstet Gynecol*. 2005;193(5):1607–1617. doi:10.1016/j.ajog.2005.03.063